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ABSTRACT

This instructor's guide contains materials for a 40-hour course designed to refresh math skills for current computer numerical control machine operators. The course uses two instructional methods: computer-based multimedia and traditional instruction. The course description lists target audience and general objective. The next section gives instructors basic information related to providing successful educational programs in a workplace setting, an instructor's lexicon of strategies and principles that can be used in teaching, instructor's role and responsibilities, and course objectives. An explanation of lesson format describes these components of each lesson plan: unit name; lesson name; description and specific goals; objectives; prerequisite skills; technology use; materials needed; teacher to teacher; pretest; posttest; purpose/rationale; procedures/activities; evaluation and extension activities; resources; and homework. A section on planning and scheduling deals with time requirements, class size, expected outcomes, prerequisites, and other materials needed. Lesson topics are as follows: whole numbers; decimal numbers; positive and negative numbers; percents; measurements and statistics; geometry; metric system; and magnitude. Appendixes include a glossary and preview and review with answer keys. (YLB)

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ED 424 388

WORKPLACE EDUCATION

Get it in Gear!

Math for Machine Operators

Instructor's Guide

Gary Powell Ed. D.,
Nancy Copeland M. Ed.
Catherine Baker B.A.

Project ALERT

Wayne State University
College of Education

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Overview of Math for Machine Operators

Description: This course is designed to refresh math skills for current CNC (computer numerical control) machine operators and provide a foundation of math skills for future machine operators. The course uses two instructional methods. The computer-based multimedia portion, *Get it in Gear!*, allows participants to work at their own pace. A traditional instructor-led portion integrates paper and pencil activities. The main goal is to provide participants with the necessary math skills for operating machinery. Participants will improve their ability to use math on the job and in their personal lives. Another goal is to understand the basic mechanics of how gears and pinions work.

The major objectives of this course are:

- To understand and describe the importance of the decimal system
- To read decimal numbers
- To add and subtract numbers in decimal form
- To add and subtract positive and negative numbers
- To describe the relationship between fractions and decimals
- To calculate averages and determine ranges
- To describe and compare the metric system to the US Standard system of measurement
- To understand magnitude (in relation to machine measurements)
- To provide a brief introduction to the Cartesian coordinate system

Length of time: This course is designed to provide 40 hours of instruction. Approximately 20-30% of instructional time is computer based.

Target audience: Present machine operators who may need to refresh math skills and future machine operators who need a solid math foundation for technical training for updated machinery.

General objective: To provide a solid math foundation to machine operators as preparation for technical training.

Introduction

Math for Machine Operators

What is this course about?

Math for Machine Operators is an instructor led course supplemented with interactive multimedia. It has been designed for plant workers of small to medium sized manufacturing companies. The course is designed to benefit all plant employees; however, it is future and present operators of Computer Numerical Controlled (CNC) machinery that will reap the greatest reward. Its primary goal is to provide adult learners with the math skills necessary to operate the CNC equipment and to fully understand the machining aspect of their jobs. The course also goes beyond that, covering many math topics necessary to function in today's technologically-oriented society.

Math for Machine Operators is a 10 week course, with two two-hour sessions per week. Pre and post testing occurs the first and last class sessions, and content review occurs during the final weeks. There are a total of 8 math units made up of 18 small math lessons (see matrix on page 2). This document includes the lesson plans, as well as other sections on managing adult learners.

Math for Machine Operators is a highly flexible course. While originally designed for Chrysler Corporation, it can be taught in any manufacturing environment where (basic) math skills are necessary to perform job functions and tasks. Though some examples or images (in the software) are related to automobile manufacturing and CNC technology, the core math instruction is quite generic. In other words, **-5.2 + 0.2 = -5.0** whether you're making car parts or cutting diamonds.

Math for Machine Operators is supported by custom designed interactive multimedia courseware called *Get It In Gear!* The courseware includes modules on addition and subtraction of decimals, reading and writing of decimals, addition and subtraction of positive and negative numbers, calculating averages and ranges, the Metric system, magnitude, and the Cartesian coordinate system. The software also includes simulations of job activities which require the application of these math skills.

The *Get It In Gear!* interactive multimedia software runs on any Window's based multimedia PC. The software makes use of sound, narration, video clips, and pictures throughout.

How is the course arranged?

The course is comprised of 9 Units which are broken down into 18 Lessons. The units can be completed in less than four class sessions. The lessons which make up the units are short, and usually take less than one class session to complete. Students should feel a sense of progress and accomplishment because they will moving from lesson to lesson fairly quickly. Each unit and lesson is designed with the same format. The units and lessons are outlined below. See Figure 1 at the end of the ***Introduction*** section for the explanation of the lesson format.

Unit Name	Lessons					
Whole Numbers	Place value, rounding, adding & subtracting	Multiplying & Dividing	Exponent and square root & order of operations			
Decimals	Place value	Reading & writing	Rounding	Adding & Subtracting	Multiplying	Dividing
Positive & Negative numbers	Adding & subtracting	Multiplying & dividing				
Percents	Converting percents and decimals & percent calculations					
Measurements & statistics	Average (mean), mode, median, & range					
Geometry	Angles (degrees)	Circles	Coordinate system			
Metric	Metric System					
Magnitude	Magnitude					

Math for Machine Operators From Whole Numbers to Algebra

What is the best way to teach adult plant workers effectively?

Know your students...

Adult learners are, above all, *adults*. They have experienced life — with its frustration, success, tragedy, triumph, embarrassment, pride, hate, love, boredom, and humor. You will certainly note how different students are from one another. This should not be surprising. People naturally become more different from one another as they grow older. Their experiences with childhood, schooling, parenting, marriage, working, worshipping, and living in the community have combined to make them unique human beings.

Adult basic education (ABE) students come to class with an infinite variety of experiences and conceptual understandings. Experienced adult educators turn this diversity to their advantage by drawing on the uniqueness of each student to enrich the teaching and learning process. As you get more familiar with your students, you'll find yourself learning while you teach.

Be mindful of their diversity...

The employees on the plant floor are — as you might have imagined — adults. They have experienced life in a multitude of ways. They reflect the diversity of people in the community, in terms of race, ethnicity, culture, gender, language and religion. It is critical that you as the instructor are not only aware of these factors, but value them as assets to the learning experience. Each learner brings culturally based rules, expectations, value systems, and needs about education to the learning environment. For your instruction to be as effective as possible, the individual characteristics of the learner, including ethnic and cultural background, must be taken into account. (Did you know that over the centuries, mathematics has been molded by the influence of many cultures - from the ancient Egyptians who used the Pythagorean theorem to the ancient Chinese who knew the value of pi to ten places centuries before the Europeans know of its existence!)

Adult students differ from one another based on prior knowledge, reading level and conceptual understandings of mathematics. Guaranteed, you will be confronted with a class of learners that range from practically non-readers (e.g. ESL) to those with significant math savvy. As an adult educator, you must turn this diversity to their advantage by drawing on the special uniqueness of each student to enrich the teaching and learning process.

Take into account their motivation...

You will also find that your students were motivated to enroll in the Math for Machine Operators course for a number of reasons. Some want to perform better on the job or improve job potential, while others are more interested in applying these skills to their life outside of the plant as better parents, consumers or financial managers. And there will be those who simply want to get away from the job for a couple of hours to play with the computers! Knowing why the workers are in your class will enable you to help them recognize the relevance of the content and understand how to use what they learn.

Anticipate student math anxiety...

Many students may have encountered failure and frustration when they first took math in school. Some may have avoided math whenever possible. In the past, women had been steered away from technical fields, many of which required math and computational skills. This contributed to math anxiety. Men also experience math anxiety. While there are many reasons for math anxiety, such as over-reliance on calculators, you should be prepared to see some of it.

Using a math diary can dispel some math anxiety. Keeping a math diary can be an effective tool for alleviating student panic and discouragement. In their diaries, students write down their feelings about the lessons, homework or their progress. In this way they can disclose their feelings confidentially about themselves, math, and the program. You may wish to have them share with you on a regular basis. If students are defeating themselves with negative self talk, a diary may help bring this fact to light. While you should respond to what they have written, this is not the time to correct the mechanics of their writing. For students with a long way to go, keeping the diary can become a testimony of the very real progress they have made.

Be friendly and made a good first impression...

Effective teaching is a critical factor at all levels of education. It is especially important in adult basic education because many adult students have had unsatisfactory experiences in school settings. They are unsure of themselves and apprehensive about enrolling in an adult education class. Your friendliness and helpfulness will make a big difference to your students.

Keep in mind that there is no single best way to teach adults. Effective teaching depends on course content; the background, personality, and learning style of the student; and your style of teaching and ability to relate to adult students.

First impressions are important. Remember that your own feelings about groups and individuals are usually shaped by your first encounters with them. This is also true of the adult students in your class. More students drop out of adult education classes after the first or second session than they do later in the term. It is very important during the first sessions to use techniques that encourage adults to continue with the class.

First sessions should be friendly and offer each student an opportunity for success. Some adults will be fearful. They may be afraid of appearing stupid or being ridiculed. This is often true for adults with little experience in adult education or with unhappy experiences in school.

A friendly, supportive climate will help students feel welcome and comfortable. Introducing students to one another is usually a good ice breaking activity. Adult students are especially appreciative of teachers who are informal, confident, enthusiastic, responsive, organized, and creative.

Beginning on the first day of class, teach something of relevance to the students. Remember that these students are in class because they want to learn something. Tell them you are not there to discover how smart they are. Rather, you are interested in discovering what they have forgotten so you can build together from that level.

During the first session, it is important that students experience success while learning something of significance to them. You can help this happen by talking with each newcomer. Find out a little about each student's background, interest, and goals. Select a learning task that is of interest to that student to be completed successfully in the first session. For example, a student with very low level skills might find using numbers in a street address or reading a newspaper ad to be a suitable task.

By providing for positive experiences in the beginning, you reinforce the fact that students can succeed. For those who are fearful of math, give them reassurances during the first session. Let your students know that even if they could not understand math before, they can understand it now. They do not need any special mathematical ability. Tell your students that you will explain everything until they understand, and you will let them learn at their own pace.

Especially encourage students not to worry about being ignorant. Even experienced mathematicians and math teachers find some problems hard to solve. Successful students have learned how to handle their frustration when they are unable to solve a problem quickly or easily. Tell students that, when they cannot solve a problem right away, they may come back to it later or perhaps discuss it with a friend. The important thing is that they never give up. If there is time, let students discuss their feelings about math. They will discover that they are not alone in their doubts and fears. Then let them share what they hope to do once they have learned more math, or let them work in groups to problem solve together. End on a note of confidence!

Use an effective, yet comfortable, teaching style...

From the first time you meet your students, you will be making an impression on them. Regardless of their academic skills, adults will be very perceptive about your teaching style. They may not know the teaching technique you are using, but they will know whether you are comfortable with it. Therefore, it is important that you do not try to be something you are not. You and your students will benefit if you use a comfortable teaching style.

To be an effective teacher, your teaching style will need to vary with the content. For example, how you teach computation skill will vary from the methods you use to teach problem solving. If a technique works, you may not even need to know why. If you do not meet with the success you desire, you might want to reevaluate your teaching style in order to relate it better to your students learning styles.

Know what your students will expect...

ABE students often have very definite ideas about what is appropriate in a teaching style. Many students expect to learn the very methods that failed them in earlier attempts at formal instruction. Frequently teachers who spend a lot of time devising creative ways to teach are dismayed to find that their students do not believe they are learning if they are enjoying the learning process. Introduce change slowly. You may gradually help students understand that , there are many ways to learn effectively.

As you develop a teaching style, use what is comfortable for you. Use whatever techniques work for you. If you are effective and feel good about your teaching, keep doing what you are doing. If you feel you are not reaching your students as well as you could, then reevaluate your teaching style and think about your students' learning styles.

Give frequent positive reinforcement...

The adult learner needs as much positive reinforcement as possible. Compliments will go much further and produce better results than remarking on inappropriate behavior or lack of skill development. The list below offers some suggestions you can include in your conversations with your students.

"You are...

- working well with others."
- actively involved during class."
- cooperative and courteous."
- asking questions that make a positive contribution to the class."
- friendly and helpful to other students."
- improving your study skills."
- putting forth good steady effort."
- developing the ability to organize and develop ideas."
- coming to class prepared and ready to work."
- showing an ability to concentrate on the task at hand.
- focused and involved."
- willing to give up some free time to improve skills."

Be ready when students have difficulties...

When students demonstrate difficulties or problems in your class, it is very important to discover the cause(s). You may find the following list of questions helpful when ascertaining the cause of any difficulties or problems:

1. Did the student have difficulty with the prerequisite topics?
2. Is this topic totally new to the student?
3. Is this a topic which has caused the student difficulties in the past?
4. Does the student feel unable to master the material?
5. Does the student feel that the topic is unimportant or irrelevant?
6. How long did the student need to complete prior lessons?
7. Is the student having some personal health problems which interfere with the ability to concentrate?
8. Is the student getting enough rest?

When students are reluctant to ask questions...

Many adult students are reluctant to ask a question in class for a variety of reasons. The following questions may help you to find out why this is happening:

1. Does the student think the questions are not important enough to ask?
2. Does the student feel inadequate?
3. Does the question occur just when the student is leaving class?
4. Does the student understand the lesson sufficiently to focus a question?
5. Is the student shy about asking for help?

When students ask questions and seek your help...

1. Remember, patience first.
2. Dignify the questions asked. Comment on how important it is to understand the point.
3. Be positive and encouraging.
4. Give a step by step explanation. Allow enough time for students to write down the steps in words and then work through them.
5. Have students complete and check at least one problem before leaving class.
6. Make sure students know they may ask for help at any time

How should I plan my teaching?

Your math class will consist of adults with varied abilities. These students will come to your class from diverse backgrounds and consequently, without common educational experiences. You, as their teacher, will need to establish a basis for meeting all their needs and affording them opportunities to reach their full math potential.

One way to assess students' needs is to acquire information about each student that will help you pinpoint the student's particular needs. Answers to the following questions may be helpful in accomplishing this:

1. What skills do students possess now?
2. What skills do students feel to be most needed?
3. What skills are most needed for their jobs?

After answering these questions, you and your students can develop a plan that will cover as many relevant topics in the class time available.

Variety is extremely important for students who have a long way to go before reaching their goals. To bolster variety in your classroom, supplement materials with everyday examples. Use plant related examples and materials, current newspaper and magazine articles and advertisements. Films, small group discussions, manipulative aids, guest speakers, field trips, multimedia, and simulation exercises will also help keep interest. In addition to providing variety, supplements can help to accommodate various backgrounds, interests, and reading levels, and to meet the needs of students with a strong learning style preference that is not primarily visual. Adults with long histories of learning problems may prefer briefly structured exercises with frequent support and encouragement. On the other hand, adults who are more self directed may prefer to study independently or to even help others in the class.

Practice, practice, practice...

Almost every learning task requires some practice or review to achieve mastery. Each lesson includes opportunities for practice. Whenever possible, provide the correct answers to problems to the students so they may check their own (or each other's) work. Self evaluation provides reinforcement and a way to focus efforts on achieving mastery through practice. The amount of practice needed to achieve mastery will vary with students and the topics.

Students who exhibit problems processing information in sequence will need more drill and practice. The "over learning" will help them recall sequential facts, such as multiplication facts.

Make particular efforts to have students utilize their new skills in practical, everyday activities. Encourage them to bring in samples of how they are using mathematics in their lives and in the plant. If students express difficulty in seeing the connection between math and their work or daily lives, some suggestions that can be shared are as follows:

- Increasing and decreasing recipes
- Figuring overtime or take home pay
- Finding the cost of a discounted item
- Determining living expenses
- Calculating the true cost of borrowing money

Vary your learning model...

The most common models in use for adult basic education programs are the independent learning model and the cooperative learning model. Note: the *Get it in Gear*! software is designed to used in a individual self-paced format.

As the teacher you can choose either model, depending upon the students who are in the class. If students will be in your class for a short period of time and need to cover only a few topics, then the independent model would be a good choice. However, if students will be in the class for a fairly long period of time and need to cover many topics, then cooperative learning activities may be the better choice.

Independent Learning Model

Room Arrangement: The room is arranged in a U shape. The teacher is more accessible to visit with each student.

Group Size: The teacher works with students in small groups or on a one to one basis.

Some Benefits: 1) With a U shape arrangement, students can observe and interact with fellow classmates. 2) If several students are working on the same topic, they can help each other. 3) Excellent reinforcement is attained when students help each other.

Cooperative Learning Model

Room Arrangement: Students in groups should face each other as they work together.

Group Size: Groups work best as teams of 2 to 5 students, as materials or activities dictate.

Some Benefits: 1) A sense of team work is developed. 2) Students accomplish more difficult learning tasks, such as problem solving, critical thinking, and conceptual learning, when cooperative strategies are used. 3) Cooperative learning promotes more learning regardless of age, subject matter, or learning activity.

Use materials to facilitate learning...

Most teachers agree that the use of a variety of materials helps students build an understanding of math concepts. Such materials assist students in bridging the gap between their own concrete environment and the abstract concepts of mathematics.

Activities that involve students in the act of physically manipulating particular materials help students experience the patterns and relations inherent in mathematics. Some suggested materials that can be used to relate concepts and develop mathematical insights are calculators, math tapes, computers, chalkboards, math games, timers, rulers, paper clips, glue, tape, toothpicks, scrap paper, graph paper, cardboard, pens, pencils, colored markers, templates of geometric shapes, chips or colored tokens, sand, beans, a two-pan balance, compasses, geoboards, tape measures, spinners, measuring cups, and containers of various sizes.

What kind of testing should I give?

Customized test

The Customized Preview and Review test is given at the beginning and ending of the course and is included in this guide. *The Get it in Gear*! software contains a Checking for Understanding section where students type what they have learned about each lesson. It is suggested that the instructor read each student's comments and provide appropriate feedback.

Unit Pre- and posttests

A pretest may be administered at the beginning of each unit. It contains questions that represent the theories and concepts that will be presented within in the unit's lessons.

You can use these pretests in the following manner:

1. Allow students time to take this pretest.
2. You and the students can work together to correct the pretest, or you can allow students to correct their pretests by providing the answers. Instruct the students to circle the missed questions on the pretest.

After the pretest is corrected, meet with each student individually to determine the areas of math in which the student's efforts and concentration are most needed. If a decision is made to skip a lesson, ensure that the students really do possess the represented skills. Enlist students' cooperation by helping them to understand that mathematics has a linear learning pattern and that success with subsequent skills will depend on their mastery of prerequisite skills.

After students complete the lessons of a unit (self checking and correcting as they proceed), they should take the posttest. Meet with each student to analyze the results together and decide what if any remediation is necessary.

It is suggested that you do not give a percentage score on the pre and posttests. Focus is on mastering the skills, not on achieving a specific score on the tests. This approach places emphasis where it belongs: on **skill development.**

Having students score their own tests helps them stay motivated and allows the teacher to spend more time helping students on a one to one basis or in small groups. When scoring posttests, have students copy the correct answers so they can rework any missed problems, find their own errors, and be able to ask for help when they are unable to figure out what errors they make.

References for each unit pre and post test are included in the lesson plans.

What are some techniques for studying mathematics?

Tips and pointers...

1. Keep a list of new mathematics terms, their definitions, and a short example of the term being used. Mathematics has a vocabulary of its own.
2. Read slowly.
3. Try studying with someone else. Working with others helps you to solve problems, stay focused, and stay motivated. One way to begin this process is to get the phone numbers of two other students in the class.
4. Review to reinforce the skills and concepts. Because we forget much of what has been learned within the first 24 hours after instruction, it helps to review the new concepts immediately after instruction. Before starting a new lesson, review the previous day's work.
5. Try to master one topic before going on to the next. Many mathematics skills must be learned in the order they are presented. To master prerequisite skills before moving on to the next topic, work additional practice problems. Write down all the steps, keeping the work neat and organized. Then, if help is needed, you can follow the work and thinking processes. It also helps for later review.
6. Find a quiet place to study. A quiet study area increases your ability to concentrate. If possible, find a place to work where distractions will be as few as possible. Note that actively listening to music often distracts, rather than adds, to concentration.
7. Estimate to figure out the correct mathematics procedures to use. Estimation gets you in the answer range. Then, once you find the answer, you will know if the answer is reasonable.
8. There may be more than one way to solve a problem. Your approach may be different from the approach of others in the class. This does not mean that your approach is wrong and their approach is right or better. Some mathematics problems can be solved in many

ways. Sometimes it helps to express aloud the process that you are using to solve a problem. If possible, discuss this process with another student or with your instructor.

9. Check your answers. Use the technique given for checking the type of problem on which you are working. After working practice problems, you can diagnose your difficulties. Do the problems over again until you get them right without looking at your previous work.
10. Persevere. Don't give up, but stick the material until you are able to do the practice problems yourself. Mathematics problems can be solved if you take your time, think about what is being asked, and use patience and perseverance to solve the problem.

The letter that appears on the next page can used to help your students feel more comfortable in their mathematics classes.

Dear Math Student:

How do you feel about taking math again? Do you think you will be able to do it? Many people think that math is too hard for them. That is not true! Sometimes math is easier for adults than for children.

Maybe there is some reason you do not like math. When you first studied math, were you afraid to ask for help? Did you miss a lot of classes? Did you think you were the only one having trouble with math? No matter what happened, you are ready for a fresh start.

In our class, you will be able to

- learn at your own pace
- keep asking questions until you understand
- practice a lesson until you know how to do it
- learn how math can help you in life
- use education software on the computer

You will be pleased to find that in a few weeks you will be able to do many things on your own with math.

Sincerely,
Your Name

Using calculators

Math teachers often disagree on the question of using calculators in the classroom. Today, however, inexpensive models are available to nearly everyone. Their existence cannot be ignored, and a positive approach to the use of the calculator may greatly benefit your students.

Most teachers feel that students should learn the addition and multiplication tables before they begin using the calculator. In most instances, this is wise. In a few cases, however, teaching students to use the calculator may be the only way to give them the ability to solve math problems. Some adults experience a great deal of difficulty in memorizing facts or remembering sequences. Using the calculator may encourage them to continue studying math. Eventually, if they keep at it, they may come to remember the basic addition and multiplication facts.

For other students, calculators can be used to demonstrate a number of math concepts, such as the fact that multiplication is repeated addition, and division is repeated subtraction.

The use of calculators can extend the students' ability to solve problems involving large numbers or time consuming calculations. You will certainly want to consider the students' capabilities and goals before making a decision on using the calculator.

Making it Work

This section of materials is provided to give instructors basic information related to providing successful educational programs in a workplace setting.

Adult learners

General characteristics of adult learners:

1. Purposeful learning occurs with adults experience a problem or recognize a gap between where they are and where they want to be, then start to draw on resources to acquire the learning they consider necessary to close the gap.
2. One of the most important issues to consider from the adult learner point of view is "What's in it for me?" An adult needs to know that there is real value in what is being taught. Customize and adapt lessons to suit your students. Make a regular effort to point out what benefit the instruction has for the student. Many times students are unaware of the applications of learning. Make sure you point out possible applications of knowledge.
3. Adult learners insist that learning have relevance and value now, contrasted to youthful learners whose education is largely subject-centered and future-oriented. Most adults are already busy with their jobs and families, so the learning must be worthwhile.
4. Adult learners will drop out of educational situations that are seen as not accomplishing their own agenda.
5. The central organizing principle for adult learning must be around finding solutions for problems adults face. Emphasis must be on helping adults learn to cope with problems they face. Therefore, the instructor must be more *person*-centered than subject-centered.
6. Adult learners are well aware of what they need to know, and they like to participate actively in all phases of their education--assessment, instruction, and evaluation.
7. Many adult learners come into programs with the "baggage" based on a history of negative educational experiences. It is absolutely essential to provide a safe, non-threatening atmosphere where risks can be taken with out fear of humiliation or embarrassment.

Environment

Creating a safe environment for learning is a key factor in success. One of the elements that is part of a safe environment is multicultural sensitivity. The following suggestions should be considered as the lessons are delivered:

1. Use multiple instructional strategies to accommodate all learning styles. See *Learning Styles* for more information on this topic. Also see *Teaching Auditory Learners, Teaching Kinesthetic Learners; Teaching Visual Learners.*
2. Avoid ethnocentrism (belief in the superiority of one's own ethnic group), use of stereotypes, critical or judgmental attitudes, fear, and rigid expectations. Strive to address the various cultures represented in the group. Try the AAAA approach to Cultural Diversity: Awareness; Acceptance/Appreciation; Action

3. Seek to understand the unique motivations of your audience in the workplace. Each worksite has a particular culture. It is important that you strive to understand and become a part of that unique culture.

4. Use materials that are not slanted toward any particular group.

Above all, the instructor must establish a learning environment in which diversity is valued. Students need to feel that their cultural backgrounds are viewed as assets to the class.

Teaching Auditory Learners

(Adapted from materials from presentation, *Designing Workplace Training to Accommodate Culturally Diverse Learners*, Douglas Jones, Linda Mrowicki, Workplace Education Division of THE CENTER-RESOURCES FOR EDUCATION, delivered Jan. 1996.)

Auditory learners learn best by listening to others. They usually do well in a "traditional" classroom.

Audio tapes: Have students or groups listen to a tape or create their own tapes for each other to listen to.

Music: Record key points on an audio cassette with background music. Write a song, rap, jingle or rhyme about the learning material.

Guest speakers: Invite subject matter experts to talk about a topic. This can be outsiders or members of the class.

Reading: Read or tell a story, for variety use music in the background.

Discussions: Use questions to get others in the class involved. Not only can students learn from the instructor, but they can learn by listening to each other, and the instructor can learn from listening to the students.

Repetitions: Repeat things out loud.

Directions: When giving directions, be sure to give them orally.

Mnemonic devices: Mnemonics are artificial aids to memory. The keyword HOMES can be used to remember the names of the Great Lakes: H = Huron O = Ontario M = Michigan E = Erie S = Superior. Sentences and rhymes can also be used; to remember which direction to turn a screw to tighten = Leftie Loosie, Rightie Tightie. Steps in basic division can be incorporated into the sentence: Donald (or Donna) made some candy bars = D = divide M = multiply S = subtract C = compare B = bring down.

Be the Instructor: Pair the class and have one individual teach the other, then reverse roles.

Concert Review: The instructor uses transparencies, pictures, charts, etc. that were used in presenting the lesson as a means of review. While playing soft music, the instructor displays and reads the instructional materials. A variation is to have a willing student read the instructional materials.

Oral Cloze: Use oral cloze (fill in the blank) activities to repeat key information.

Teaching Kinesthetic Learners

(Adapted from materials from presentation, *Designing Workplace Training to Accommodate Culturally Diverse Learners*, Douglas Jones, Linda Mrowicki, Workplace Education Division of THE CENTER-RESOURCES FOR EDUCATION, delivered Jan. 1996.)

Kinesthetic learners learn best by doing. They like to be physically expressive. They also need to stretch and move periodically. The following are activities that enhance kinesthetic learning.

Walking and studying: Allow students to walk while they study.

Role playing: Use props and costumes while role playing. Can be done with a group or in pairs.

Action learning: Includes anything that requires people to use their bodies in some way while they learn. It could be a song, a dance, a mime, a physical acting out of a technology or process, or an active performance of the learning material where learners become interacting components of the material they are learning.

Strolling review: Have the group prepare colorful flip charts as a means of review. Hang them around the room Play music softly as individuals walk silently around the room, carefully observing the wall display or examining the mind maps created by other learners. A variation is to play music while individuals stroll around and review.

Being the Coach: Ask one partner to be the coach while the other partner learns to perform a new task. After one run, reverse roles.

Demonstrating: Allow class members to demonstrate and physically do an activity. Provide opportunities for practice using repeated motion.

Writing: Writing requires students to use parts of their bodies. Write on surfaces with a finger. Write in the air. Trace on sandpaper. Take notes. Write lists.

Sequencing: Using a topic that has several steps or procedures, give each individual a piece of paper with the words or a graphic depicting one step or procedure. Ask the group to move around until they are in the correct sequence. An option is to act out what is on their piece of paper.

Teaching Visual Learners

(Adapted from materials from presentation, *Designing Workplace Training to Accommodate Culturally Diverse Learners*, Douglas Jones, Linda Mrowicki, Workplace Education Division of THE CENTER-RESOURCES FOR EDUCATION, delivered Jan. 1996.)

Visual learners like to process, store, and retrieve information visually. The following are examples of activities that instructors can use to facilitate the visual learner.

Demonstrations and modeling: Since visual learners like to understand the "big picture," it is important to show or model all of what is expected before breaking it into its components.

Draw: Simple illustrations can be used to reinforce important information. Encourage students to draw as a means of committing key information to memory.

Imagery: Imagery is the mental visualization of objects, events, and arrays. The typical technique is to ask students to form a mental picture. It usually works best for concrete information and less well for abstract information. Images are better remembered if they are vivid and show some type of movement.

Study Guides: Study guides are used to summarize key information. They are useful for reviewing key points. Instructors can create study guides, or better yet, allow students or groups of students to prepare a study guide.

Graphic organizers: These are visual tools which can show the relationship of categories of information. Charts, graphs, and maps can be used to show relationships visually. They are also good because they usually show or explain a concept holistically. Instructors can create blank charts or matrices for the learner to complete.

Mental Imagery: Have learners rehearse or practice a knowledge base or a skill in their minds.

Mind mapping: Ask individuals to mind map a lecture or presentation, a written lesson, an article, an audio tape, a recollection, an experience, or anything relative to the learning situation that might be significant.

Note taking: Encourage visual learners to take notes using words or pictures. This provides them with another opportunity to visually rehearse the information. Note taking can also be done using a map which allows them to see the "big picture."

Create notebooks: Using notebooks for class projects provides another way for students to see the information in their own words. It allows them to "customize" the information and make it their own.

Color codes: Visual learners like to see different things/views. Use color as a means of focusing attention, or use it as a means of changing the environment to add interest visually.

Study cards: Study cards use the visual sense to present the information. They can be used individually, with partners, or in large groups. Cards can be prepared by the instructor or students can prepare their own

Pictures: Watch TV, filmstrips, movies, videos, etc. Another option is to have the group create their own video.

Mnemonics: Create acronyms, draw visual chains, or develop acrostics.

Directions: When giving directions, give them visually.

Tips on Teaching

1. Use logical sequences. Avoid jumping into topics without developing background or relevance for the skill at hand.
2. Control length of lessons into manageable chunks. Many employees come into classes at the end of a long and tiring day. Pace lessons so students can have short breaks.
3. Give recognition and encouragement. It is vial that you recognize and encourage all your students' progress toward their individual goals. Unfortunately, often adult learners are not supported by friends and family who view time spent in class as time taken away from them.
4. Use coaching. Model new skills. Point out the problems or pitfalls many students have with lessons. Repeat explanations several times or a period of time and several ways to accommodate all learning styles. Be there for them.
5. Encourage involvement. Make sure students hear you validate how important it is to learn new skills. Techniques that make provisions for active involvement of students will achieve learning faster than more passive teaching techniques.
6. Give feedback. Adults need to be reassured that they are on track. Give feedback often, and be sure to give negative feedback along with something positive.
7. Use summaries and advance organizers. When materials are detailed or involved, help students see the "big picture."
8. Questions will help you assess how your students are understanding. Make sure they are not accusatory in tone. It is possible to inadvertently press a "hot button" based on a students' unpleasant school memories. Maintain a safe atmosphere for students when questioning them.
    - Direct questions are usually *yes* or *no*, or short answer. They are easy to control.
    - Open-ended questions are more likely to prompt discussion. They are not as easy to control.

Instructor's Lexicon

The following lexicon is provided to remind teachers that there are a variety of strategies and principles that can be employed in teaching. When you are not getting the response you expect, when faces are blank or bored, when attendance starts to slip--*try something else*.

Anticipation Guides (Readance, Bean, and Baldwin) Prepare students for reading by asking students to reach to a series of statements prepared by the teacher in advance. Expected response is TRUE or FALSE.

Application of concepts to different situations- learning that is applied immediately is retained longer and is more likely to be used immediately than that which is not. Techniques must be employed that encourage the immediate application of any material in a practical way.

Application to individual situation --Provide real life or real work scenarios for which students read different texts to solve problems

Article/pictures

- 5 W's (Who, What, When, Where, Why/How)
- Antonyms/Synonyms
- Match or rewrite topics/headlines
- Change time, place, people and rewrite
- Write questions with higher levels of critical thinking

Brainstorming--All responses are accepted, no judgment. Activates background knowledge. Gets students thinking before they read or write.

Cartoons- students fill in blank balloon with appropriate response

Categorical Overview-- Write down associations , think how they are related, categorize information, and label.

Cloze-- It is a method of systematically deleting words from a prose selection and then evaluating the success a reader has in accurately supplying the words deleted. In a given passage the first and last sentence is provided in tact. Thereafter selected deletions are made. *Ex.* Every 5th or 10th word; Initial/final letter; Word/ phrase; All nouns or verbs, etc.

Clustering-- Similar to mapping, adds visual dimension to the process of organizing ideas, helps students separate ideas into categories. Improves organization of thoughts for speaking or writing.

Coded Vocabulary--Student marks words that he knows with an asterisk, check mark for words he has heard of, and circles the words that he does not know.

Compare and contrast--Write or discuss similarities (compare) and differences (contrast)
Concrete Items/Demonstrations-- Including actual items in classes helps those learners who need more tactile or kinesthetic learning experiences understand. Visual and audio learners have an easier time with traditional formats than other kinds of learners.

Continuum of Descriptors--Write adjectives on a line to show degrees of modification, such as minuscule, tiny, small, average, big, huge, enormous

Cued Retelling (See article on Retelling--Free and Cued)

Cubing--On a paper cube, write down one of the following words on each side of the cube: describe, compare, associate, analyze, apply, argue for. When writing or discussing an object/concept, have students write about it using the suggestions from each side of the cube.

Designated Roles (Cooperative learning)
Listeners note points of disagreement
" " what is not said
" " questions to ask

DRAT (Directed Reading/Thinking Activity-Haggard, 1985)
Activate prior knowledge
Predict what will be covered
Read to designated point
Confirm, revise, or elaborate prediction with information from text
Continue in similar fashion through text.

Dyads
confirm/explain
make decisions
draw conclusions

Find someone who . . . --an ice breaker activity to raise awareness of the depth of experience and diversity in the class. Typically you can only get another person to sign your sheet once. Categories can be as generic as "find someone who has more than 5 brothers and sisters" or "find someone who speaks another language" to class specific information like "find someone who has read a the work of Edgar Allan Poe." It can be designed for many topics but always helps students get comfortable with each other.

Flash card directions--Challenge learners to read more than one word at a time by giving direction quickly on flash cards. Ex. Put your hands on the table.

Free-writing/thinking
Can you think of a time . . .
Questions regarding topic

GIST--requires readers to reduce the first sentence of a passage to 3 or 4 words. The next two sentences to 5 or 6 words. The next three sentence to 7 or 8 words. This requires readers to make meaning and determine their own key words.

INSERT (Interactive Notation System for Effective Reading)--Students place a √, X, +, !, ?, ?? and * besides ideas they read to indicate whether they understand it (√), are excited about it (X), don't understand it (?) , are stumped by it (??), or want to remember it (*).

Interviewing--Encourage students to generate a list of questions that would give them the information they would like to find out about someone. Have students break into pairs and interview their partner, using questions. Then let each introduce his/her partner using the information obtained.

Jigsaw/segmented reading --Instructor assigns parts of a selection to different readers. Readers read their part silently. Each reader shares what they read with group.

Journals--Students write reaction to class, write comments, write questions. Instructor does not judge them on technical competencies. May be used to tie topic of class to learner. If topic is American Education, journal writing questions could be: Where did you go to school? What did you like best in school? What irritated you the most? Why did it irritate you? Who was your favorite teacher? Why did you come to this class?

Key word predicting activity--Instructor selects passage and notes 10 key words. Words are shared with learners who are asked to predict content. Learners should try to make sense of key words. Next, learners read passage and find out if predictions are on target.

K-W-L--(Ogle, 1986) Students identify what they **K**now about a topic , what they **W**ant to find out about a topic, and what they **L**earned about the topic.

LEA (Language Experience Approach, Stauffer, 1970) Students dictate sentences about an experience as instructor transcribes. This text become the reading material for that student.

Learning style--The 3 major learning modalities:

Visual-needs to see material
Auditory-needs to hear material
Kinesthetic- needs to move around while learning

LINK-- L= List I= Inquire N=Note K=Know List all associations for concept/topic on overhead/chart; inquire - give examples, clarifications about associations; note - write what comes to mind for one minute (overhead off/chart covered); know - what I know now about this concept/topic?

List and skip-- instead of looking up words as you read, use a *List and Skip* bookmark. Write down unfamiliar words from reading selection. After completing selection, look to see if any words were understood through use of context.

Main Idea-- explanation overheard by instructor between students. "How would you tell your mama what the (article, book, chapter) was about if you were calling her long distance?

Mapping (Baumann, 1991)--Arranging key terms into a diagram that is meaningful to the student. It can include the following:

Key words/phrases
Structure
Questions
Connecting lines/circles

Is a graphic representation of the relationship between major ideas and supporting details.

Metacognition - Being aware of how you learn, and the process of thinking through a learning situation. The development of self-questioning or monitoring of patterns of thinking, which helps students become an independent learners who can recognize and correct their processing errors.

Questions with others

What do you think about . . .?
Why is . . . used for . . .?
What would you do if . . .?

Paired Questioning --Divide students into pairs, read passage, close book. Each in turn asks questions with the other answering; tells important ideas; paraphrases or summarizes; agrees/disagrees; draw picture or graphic representation of what learned.

Reading strategies-- Good readers bring what they know about the topic to the print on the page. They are active readers. Good readers take chances, they risk being wrong. Good readers guess at or skip words they don't know and read on for help. Good readers expect the material to make sense. Good readers try to match reading speed to what they are reading.

Reading techniques

see: Flash card directions
see: GIST
see: Key word predicting activity
see: List and Skip
see: Word Bank

Reciprocal questioning

Students work in pairs
Both read a portion of a reading selection.
One asks the other a question.
Continue reading selection
Alternate asking questions.

Retelling/rewriting- Can be free retellings, cued retellings, and/or cued comprehension questions. Provides an opportunity for students to reflect and revise their thoughts. Teachers can record students thoughts without having to infer right or wrong choices. Possible prompts: *Write down everything you can remember about the selection you just read.* Provide a list of words from the passage, and then, *Use these words to help you remember everything you can about the passage. See Retelling--Free and Cued*

Retelling--Free and Cued - A **free retelling** allows a reader to structure his or her demonstration of comprehension without the constraints often imposed by a testing situation. If the objective of the assessment is to find out how the student is thinking about the content rather than how much he can demonstrate that he knows, the unprobed (free) retelling is probably the best response.

Researchers find the free written retelling to be an invaluable tool as they explore issues related to reading comprehension. Retellings allow analysis of the link between the response and the original source (the text). Many teachers are reluctant to use them because they do not lend themselves easily to objective scoring.

Since remembering and understanding are not synonymous, there is value to using retrieval cues as an aid to comprehension. By including word or phrase cues the reader has the freedom to indicate his or her comprehension according to personal dictates while simultaneously providing bits of text to help dissolve the confusion between what is understood and what is remembered.

Cued retellings may be the best of both worlds.

In order to do this form of assessment, the teacher needs to have comprehension questions in mind. the perspectives on comprehension that are to be checked should be noted.

Were the students responses text explicit (Just the facts recited)

Were the responses full of nonessential details? (Not important to understanding the essential message of the passage)

Does the student understand the essence of the passage? (Main idea)

Unless you assess students' comprehension with the intent to learn what students do and do not remember, you can only speculate about their comprehension and the appropriateness of your instructional focus.

Say Something- 2 students read a passage to a designated point Each has to say something about the reading

Segmented reading --see: Jigsaw

Semantic map--see **Mapping** and **Webbing**

Sequencing--*Paragraphs*

- Articles are cut into parts based on content.
- Student reads each part

Student orders the parts based on content

Pictures
- Cartoons or picture sequences are cut apart
- Student orders the part based on content

T Chart -- (Johnson & Johnson)Write the name of a skill to be learned or practiced and draw a large T beneath it. · Write "looks like" on the left side of the T and "sounds like" on the right side. On the left side list behaviors that one might see in someone exhibiting this skill. On the right side list phrases that might be used by someone exhibiting this skill.

Think aloud- (Davey)Instructor models and tells the thought process for an instructional piece of material.

Three-way rotation--Three different ways of saying the same thing.
Time line-- Events are placed on a time line to visualize the relationship of events in respect to what else was happening at the same time.

Total Physical Response (Asher)--incorporates listening to directions or commands like, "STAND UP!, SIT DOWN!" and they respond to commands without speaking. Used most effectively in early ESL situations.

Transformation- charts, graphs, maps, forms -learn key idea and transform into different format/media Ex. Act out without words Make a chart or form to explain information to others

Webbing-- Similar to semantic mapping - as a graphic representation of the relationships between major ideas and supporting details. After reading, introduce the central question/idea circled on an overhead or chart. Encourage students to identify supporting secondary ideas, which branch off from the central idea. Supporting details are then supplied for the secondary ideas in a logical fashion.

Word bank--a versatile tool for vocabulary learning. Excellent warm up before reading and writing, assessing prior knowledge. Select a topic related to reading. "When I think of _______ I think of _______" Instructor fills in blanks then asks, "What do you think of? Try to generate 25-50 words per topic.

a. Builds critical thinking skills by clustering words that belong together.
b. Try adding prefixes and suffixes. Discuss how changing the form can change meaning.
c. Focus on spelling; note roots and affixes, number of syllables.
d. Plan a writing exercise. Determine organization according to purpose.
   How to = chronology
   Personal experience = narrative
   Description = topic characteristics.
e. Add vocabulary words as they are discovered through reading or conversation

Instructor's Role and Responsibilities

There are four main responsibilities in your role as instructor of this class.

1. **Instruction** -- As the instructor you will choose the lessons and gauge the depth of instruction based on the needs of your students and the accomplishment of the objectives.

2. **Assessment** -- This vital part of your role should be handled with great sensitivity. Many adults have not been in a classroom setting for a long time. For some, the testing situation and facing the results of tests is an extremely stressful experience that can cause them to drop out of the class. diffusing the anxiety of the testing situation is a necessary part of your role.

The Pre test should be giving before instruction begins to gauge the level of your students' understanding and prior knowledge of course content. The Post test should be given at the end of instruction. Results should be compared to see if instruction made a difference.

3. **Keeping attendance records** -- In some work situations, attendance is mandatory. In others, employees are paid to attend and accurate attendance records should be maintained.

4. **Other records** -- Anecdotal comments and observations, especial in regard to learning or change, should be documented. Companies and unions are very interested in this kind of feedback and may want to use quotes for recruitment or promotional activities.

This lesson format encourages you to keep notes on how individual lessons worked and what changes might be made to make the lesson more effective to your particular situation.

Objectives

The major objectives of this course are:

- To understand and describe the importance of the decimal system
- To read decimal numbers
- To add and subtract numbers in decimal form
- To add and subtract positive and negative numbers
- To calculate averages and determine ranges
- To describe and compare the metric system to the US Standard system of measurement
- To understand magnitude (in relation to machine measurements)
- To provide a brief introduction to the Cartesian coordinate system

Explanation of Lesson Format

Lesson Plan

Unit: state the name of unit

Lesson: state the name of lesson/lesson #

Description and specific goals: **describe** the lesson (overview), and state the overall goal(s) of the lesson. The description/overview should be a short paragraph. Goal example: In this lesson, students will learn to add decimal numbers....

Objectives: state the objectives of the lesson

Prerequisite skills: state the prior knowledge's, skills and abilities necessary to complete this lesson. Example: students should be able to....students should have a working understanding of...students should have a working knowledge of...

Technology utilization: state which part(s) of the *Get It In Gear!* software relate to the lesson.

Materials needed: state materials the students will need for lesson, such as calculators, pencils, etc.

Teacher to teacher: state any background information, tips, suggestions, etc. for the instructor. Also suggest ways to start the lesson. Example: Setup time is...lecture time is...time on the computer is...students work in groups...key concepts and vocabulary words are...be prepared for...teacher should become fluent with software program before using it as an instructional tool...talk about...ask students to think about...talk about the benefits of...students must be at this level...

Pretest: attach the copy of the lesson pre-test (with answers)

Posttest: attach the copy of the lesson post-test (with answers)

Purpose/rational/WIIFM: state the purpose, rational and what's in it for me from the learner's point of view.

Procedures/activities: this aspect has two sections, off the computer and on the computer. Off the computer describes what the instructor and student will do during the course of the instructional episode(s). Be specific, and state the steps in some logical order. Be sure to mention any life skill activities used, problem solving problems, practice problems or word problems. On the computer describes what the students will do with the software, including launching it. Be sure to delineate group or cooperative activities from individual activities.

Evaluation/assessment and extension activities: state the types of questions (or quizzes) utilized to make sure the objectives have been mastered, and the activities that will help with the transfer of this learning to the job (in other words, connect back to their work). Example: What would you do if you saw a measurement displayed in metric? How long would it take to walk to Atlanta? It is important to follow-up each lessons with some thoughts to ponder or activities to "bring it all home" and to get them communicating. For example, ask students if they feel the plant should switch to metric. You want to tie it all together. These evaluation/assessment activities that the instructor does with the students is not the same as the posttest.

Resources: state any resources needed such as text books.

Homework: state any homework assigned. Example: Try this! Research the Egyptian's contribution to math. Try this! Find places where decimals are used in the newspaper. Try this! Do these math word problems.

Figure 1.

Planning and Scheduling

Time Requirements

This class is designed to contain approximately 40 hours of instruction; however, the format of the course allows the instructor the flexibility to customize lessons to fit into available time slots. Due to the variety of student skill levels and interests, the instructor will make many decisions on lesson length and inclusion. The goal is to suit the lesson to the learners. The interest in the topic, amount of prior knowledge, and skill levels of the students will determine the length of the lessons. Our experience has shown a time range from 30-75 minutes per lesson is workable and our best estimate is included with each lesson plan. Some very difficult lessons may require several sessions.

Size of Class

The size of this class is determined by the number of computers that are available. It is best that students work alone on computers. Classes that are less than 10 are ideal. The instructor can circulate and monitor individual progress.

Expected Outcomes

Participants of this class will improve their math skills through the discussion and practice of sound principles of learning and application to job-related and personal situations.

Prerequisites

There are no math prerequisites for this class except for a willingness to learn about math and how to use the technology. Those with difficulty in reading will be given as much instructor support as possible. The computer program includes narration on each screen to assist those students with limited reading skill.

Recommended Resources

The following resource materials are used in conjunction with several course activities. We recommend these materials for effective use of the lesson plans. Pre and post tests for each lesson are located in the Essential Mathematics for Life books. The optional resources are suggested reference materials for the instructor. See reference section for complete citations.

1. Essentials Mathematics for Life: Books 4, 5, 6 and 7, 4th edition, Glencoe, McGraw-Hill, New York, New York.
2. Essentials Mathematics for Life: Instructors Guide, 4th edition, Glencoe, McGraw-Hill, New York, New York.
3. Smart Solutions Series, New Readers Press, Syracuse, New York.

Optional

4. Contemporary's Number Power Series, Contemporary Books, Inc., Chicago, IL.
5. Practical CNC-Training for Planning and Shop, Part 1: Fundamentals, Gardner Publications Inc., Cincinnati, OH.

Lessons and Materials

Whole Numbers

Unit: Whole Numbers

Place Value, Rounding, Addition, and Subtraction

Description	In this lesson, students will learn the place value of digits in any size number on either side of the decimal point. The lesson explains our number system and the important parts. This lesson will use charts, definitions, examples and practice problems to help students identify the value of any digit. Also in this lesson students will learn to round numbers to any designated place value. There will be an explanation why and when it is appropriate to round off numbers. The student will learn to round up or down and use the #5 as a key indicator. Included in this lesson are definitions, examples, and practice problems. Lastly in this lessons, students will review the procedures for adding and subtracting whole numbers. The emphasis will be to review carrying and borrowing. It is noted that students may very well know these procedures due to the real life need to perform them daily. Therefore, the life skill examples could be used so as not to insult the students.
Objectives	*Students will be able to:* ➢ Given any underlying digit in a whole number or decimal number, the student will identify its place value without error. ➢ Given a number between 999,999. to .999,999 the student will round to a designated place value without error. ➢ Given two numbers between 0.0 to 999,999. The student will add or subtract them without error. ➢ Student will be able to state procedures for adding and subtracting.
Prerequisite skills	*Students should:* ➢ be able to recognize the shapes or symbols that depict whole numbers. ➢ be able to count whole number in successive order. ➢ have a working understanding of large and small numbers. ➢ have a basic working understanding of the adding and subtracting procedures for whole numbers.
Technology Utilization	The Introduction to Decimals module of *Get it in Gear! (GiiG)* contains a section on decimal place value.
Materials	*GiiG* software, disk, paper, pencil, calculator, whiteboard, markers, and handouts

Teacher to Teacher	**Key concepts and vocabulary words:** *number system, digits, place value, comma, how to read and write the numbers, the number 5, rounding up or down.* ***Time***: approximately 1 hour for lecture, 45 minutes on computer, 1 hour for practice, and 1 hour for homework; minimal setup time. Students will work individually in this lesson. Activate prior knowledge of place value, rounding, adding and subtracting. Give several examples of the procedures along with definitions, and explanations. Be sure to mention the benefits of these skills on the job and in personal life. Emphasize the importance of accuracy to job. Be prepared for students that may recall this information quickly. They can be called upon to help explain some of the concepts and procedures. Students must have the prerequisite skills listed above. Review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 1-3 and 30-31

Purpose	Explain that even though these concepts seem elementary they are the basis for which all math concepts and procedures derive. It will be beneficial to review and master these so the further you go in math the better it will be understood. Explain that understanding place value is important for the job as well. Place value and adding and subtracting whole numbers are part of making adjustments on CNC equipment.
Procedures	**Off computer**
	1. Begin explanation of place value chart on the board ➢ Draw an example of one and ask students if they remember how to fill it in. ➢ Fill in the blank lines with them, emphasizing the differences between the right and left sides of the chart. ➢ Explain why the place values are based on the #10 and the basic differences between decimal numbers and whole numbers. ➢ Explain how to read and write the larger numbers. ➢ Show them the procedure for determining the value of a digit in a number. ➢ Check for understanding by asking each student to type the notes on the board into their notepad. ➢ Ask students if they remember how to say the #5 in several example numbers on the board.

	➢ Explain the meaning and use of the comma and the decimal point. ➢ Ask students to copy the new information from the board to check for understanding. 2. To begin the explanation of rounding, ask the students to recall the procedure. 3. Explain the importance of rounding and when it is appropriate to round numbers. 4. Explain the procedure for rounding numbers using several examples. Have students type in new information into notepad. 5. Give students sample numbers to round-off on a handout. Allow 5 minutes to complete. 6. Explain how the previous information is useful for adding and subtracting whole numbers. Provide examples of adding and carrying and subtracting and borrowing. 7. Wrap up the lesson with practice handouts that can be used for homework as well.
Procedures	**On computer**
	➢ Have students launch *GiiG* and work through the place value section of the Introduction to Decimals module. ➢ Students will enter notes from lecture into notepad. ➢ They have the option to print the notes if they want.

Evaluation / Assessment	Check homework handout. Check notes in notepad
Resources	Essentials Mathematics for Life - # 7
Homework	Handouts from Essential Math book pages 5, 7, 8, 9, 11, 12, 14, 15. Also take one shelf in kitchen pantry that has the most stock on it. Add up all the products to get an exact amount of how much it costs. Now count up the number of shelves in the kitchen that have food and food supplies on them. Make an estimate on how much money all of the items cost and round that number off to the nearest hundred or thousand. This will be an estimated inventory of your kitchen.

Place Value

hundred thousands	ten thousands	thousands	hundreds	tens	ones		tenths	hundredths	thousandths	ten thousandths	hundred thousandths
0	0	0,	0	0	0	.	0	0	0	0	0

⇐__________whole numbers__________| |__________decimal fractions________⇒

⇑

decimal
point

Unit: Whole Numbers

Multiplying and Dividing

Description	In this lesson, the students will learn to both multiply and divide whole numbers. This lesson will incorporate the multiplication chart, examples of problems, explanation of procedures, practice problems and homework. The numbers used as examples will range from zero. To 999,999. Negative numbers will not be used. Students will perform the operations by hand.
Objectives	*Students will be able to:* ➢ Multiply two whole numbers ranging from zero to 999,999 without error. ➢ Divide two whole numbers ranging from zero to 999,999 without error. ➢ State the rules and procedures for multiplying and dividing.
Prerequisite skills	*Students should be able to:* ➢ add and subtract whole numbers. ➢ recognize whole numbers. ➢ have a working understanding of place value and carrying.
Technology Utilization	None
Materials	Computer, printer, disk, paper and pencil, calculator, whiteboard, markers, and handouts.
Teacher to Teacher	**Key concepts and vocabulary words:** *divisor, dividend, multiplier, multiplicand, the definition of multiplying and dividing, steps for long division, steps for multiplying, the multiplication chart 1-12, multiplying with zero, dividing with zero.* ***Time:*** approximately 1 hour for lecture, 1 hour for practice, and 1 hour for homework ; minimal setup time. Students can work in groups for this lesson. Activate prior knowledge of multiplying and dividing whole numbers. Give several examples with explanations of procedures. Mention how often we multiply and divide in daily routines on and off the job. Students may recall this information quickly. They can be called upon to help explain key concepts. Be sure to review the students pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 1-3 and 30-31

Purpose	Explain that without multiplication and division skills, the rest of math would not be understood. Also explain the importance of these skills on the job.
Procedures	**Off computer**
	1. Begin with passing out the multiplication chart. 2. Ask students to recall the procedure for multiplication of two whole numbers. 3. Explain the procedures using several examples. 4. Have the students complete several practice problems. 5. Ask students to recall the procedures for dividing two whole numbers. 6. Explain the procedures using several examples. 7. Ask students to complete several practice problems. 8. Ask students to briefly write a paragraph on why they think multiplication and division skills are necessary in the workplace and in our personal lives, on paper.

Evaluation / Assessment	Check homework handout.
Resources	Essentials Mathematics for Life - # 7
Homework	Handouts from Essential Math book pages 17 and 20. Have each student come to the board to complete a few problems that the teacher gives orally. The students can correct each others' answers. Give students a list of rules and procedures that do and don't relate to multiplication and division. They need to pick out the ones that apply and put them in order.

Multiplication Table

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1	2	3	4	5	6	7	8	9	10	11	12
2	2	4	6	8	10	12	14	16	18	20	22	24
3	3	6	9	12	15	18	21	24	27	30	33	36
4	4	8	12	16	20	24	28	32	36	40	44	48
5	5	10	15	20	25	30	35	40	45	50	55	60
6	6	12	18	24	30	36	42	48	54	60	66	72
7	7	14	21	28	35	42	49	56	63	70	77	84
8	8	16	24	32	40	48	56	64	72	80	88	96
9	9	18	27	36	45	54	63	72	81	90	99	108
10	10	20	30	40	50	60	70	80	90	100	110	120
11	11	22	33	44	55	66	77	88	99	110	121	132
12	12	24	36	48	60	72	84	96	108	120	132	144

Unit: Whole Numbers

Exponents and Square Roots, Order of Operation

Description	In this lesson, the students will learn how to convert exponent numbers into whole numbers, find the square root of a whole number (perfect roots only), and use order of operations to solve problems with more than one operation. Also there should be time to have a brief review of the whole number operations and the taking of a timed post test.
Objectives	*Students will be able to:* ➢ Convert a number in exponential form to a whole number without error. ➢ Convert two whole numbers to exponential numbers without error. ➢ Find the square root of a whole number without error. (Perfect roots) ➢ Solve a problem with many operations without error.
Prerequisite skills	*Students should be able to:* ➢ Multiply and divide whole numbers ➢ Add and subtract whole numbers ➢ Have a working understanding of the use of parentheses.
Technology Utilization	None
Materials	Computer, printer, disk, paper and pencil, calculator, whiteboard, markers, and handouts.
Teacher to Teacher	**Key concepts and vocabulary words:** *exponent, root, base, parenthesis, multiplication, division, addition, subtraction, "Please excuse my dear Aunt Sally"* ***Time***: approximately 1 hour for lecture, 1/2 hour for practice, and 1 hour for homework; minimal setup time. Students can work in groups for this lesson. Explain the procedures for exponents, square roots and order of operations. Be sure to activate prior knowledge. Use many examples and practice problems. Spend time reviewing the previous concepts with examples and try to tie them all together. Be sure to review the student's pre-test to determine areas of weakness. Give the post test during the last half hour.

Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 1-3 and 30-31

Purpose	Explain that without multiplication and division skills, the rest of math would not be understood. Also explain the importance of these skills on the job.
Procedures	**Off computer**
	1. Introduce lesson by stating objectives and purpose. 2. Review prerequisites needed and ask students for prior knowledge on exponents, square roots and order of operations. 3. Explain the steps for converting exponents to whole numbers. Give several examples. 4. Give students opportunity to copy information into notepad and give students a few practice problems on the board. 5. Explain the steps to convert a whole number into an exponential number. Give several examples. 6. Give students a few practice problems on the board. 7. Explain the steps to finding the square root of a whole number. Give several examples. 8. Give students a few practice problems on the board. 9. Explain the reasons for order of operations. Give the phrase: "Please excuse my dear Aunt Sally " to help them remember the order and the operations. Give several example problems. 10. Give students a few practice problems on the board. 11. Explain the purpose of the post test. 12. Give the post test.

Evaluation / Assessment	Post Test.
Resources	Essential Mathematics for Life, Book 7
Homework	Handouts from Essential Math book pages 22 and 24

Decimal Numbers

Unit: Decimal Numbers

Decimal Place Value

Description	In this lesson students will learn to identify the place values for decimal numbers. Students will learn the place name for digits up to five places to the right of the decimal point. The lesson also requires students to determine the value of decimal numbers with 1-5 places. Decimal fractions are the main focus of this lesson. The decimal point is discussed as a separator for the whole and fractional part of a decimal number.
Objectives	*Students will be able to:* ➢ Given two decimal numbers with five decimal places, identify the correct digit for each decimal place. ➢ Given a blank place value chart and a decimal number, fill-in the chart with the correct digit for each place.
Prerequisite skills	*Students should:* ➢ Understand the concept of whole numbers ➢ Identify place values for whole numbers ➢ Understand the concept of large and small numbers
Technology Utilization	The Introduction to Decimals module of *Get it in Gear!* software contains a lesson on the decimal system and place value .
Materials	*GiiG* software and disk, paper and pencil, Place Value Chart, whiteboard, markers, memory aid for decimal place names, and cube model.
Teacher to Teacher	**Key concepts and vocabulary words:** *decimal number, decimal point, decimal place name, decimal place values, place holder, leading zero.* ***Time***: approximately 30 minutes for lecture and 30 minutes on computer; minimal setup time. Most adult students are familiar with decimal numbers and will have real life examples - use them as much as possible. Explain that understanding place value is necessary for reading and writing decimals and is basic to understanding all math operations used in the workplace. The instructor should be familiar with the introduction module in *Get it in Gear!* Be sure to review the student's pre-test to determine areas of weakness.

Unit Pre &	Essential Mathematics For Life, Book 7, pp. 32-33 and 46-47

Post test	

Purpose	Explain that students use decimal numbers in many situations on the job and in personal life. Understanding place value is necessary to accurately read and write decimal numbers. Since **decimal numbers are an important part of CNC, understanding decimal place value is critical.**
Procedures	**Off computer**
	1. Introduce lesson by discussing purpose and objectives. 2. Review necessary prerequisite skills: whole numbers, whole number place value, small and large numbers. 3. Begin lesson by discussing the relationship of decimal place value to whole number place value. Review the importance of being in the right place. 4. Explain that students will now work with numbers that are smaller than one. Have students provide examples of how they use numbers smaller than one: "Go a quarter (1/4) of a mile down the road; this part should be one tenth (.1) smaller". 5. Discuss the concept of decimal system and decimal numbers. Point out that decimals are numbers less than one and are to the right of the decimal point. 6. Using a place value chart, explain the **decimal place value name**. Use the place value chart to show the place value name of each digit up to five places to the right of the decimal point. Be sure to emphasize **"th"** endings. 7. Go through a number of examples having students identify the correct place value of selected digits. Use the place name chart to help students remember decimal place names: 8. Explain the concept of **decimal place value**. Help students to understand the value of each decimal place and what it actually means. Use the cube model to show .1 is one tenth of a whole part, .01 is one hundredth of a whole part, etc.. Discuss how each place value to the right of the decimal point is divided by ten. 9. Explain the use of zeros as place holders before the decimal point and after the decimal point.

	10. Have students practice identifying place value using *GiiG*. Write on the board (or use a handout) ten decimal numbers. Underline various digits and have students name the correct place value. Have them work individually or as a group.
	11. Review the concept of place value. Tie into the work environment as you review. Reemphasize the importance of decimals in the plant, and how understanding place value affects their ability to read and write decimals accurately.
Procedures	**On Computer**
	Have students to launch the *GiiG* program, and work through the Introduction Module. Facilitate as needed.

Evaluation / Assessment	Place Value Practice Handout
Resources	➢ Essential Mathematics for Life, Book 7 ➢ Contemporary's Number Power ➢ *GiiG* Software
Homework	Assign only if students have a problem understanding place value. Using student examples from work and/or home, have students identify and name place values using numbers with five decimal places.

Decimal Place Value Names

Decimal place value names and their position

	Example
1. Think of the place value name without the **“th”** on the end.	tenths without the **“th”** is **ten**.
2. Determine how many zeros are in the number	the number **10** has **one zero**.
3. Match the number of zeros with the number of places after the decimal point.	tenths = 1 place after the decimal point .1

Examples

Whole Number	**has**	**No. of zeros**	**Decimal Place Value Name**		**No. of Places to the right of the decimal point**
ten (**10**)		**one** zero	**ten**ths	=	**1** decimal place (**.1**)
hundred (**100**)		**two** zeros	**hundred**ths	=	**2** decimal places (**.01**)
thousand (**1,000**)		**three** zeros	**thousand**ths	=	**3** decimal places (**.001**)
ten-thousand (**10,000**)		**four** zeros	**ten thousand**ths	=	**4** decimal places (**.0001**)
hundred-thousand (**100,000**)		**five** zeros	**hundred thousand**ths	=	**5** decimal places (**.00001**)

Place Value

hundred thousands	ten thousands	thousands	hundreds	tens	ones		tenths	hundredths	thousandths	ten thousandths	hundred thousandths
0	0	0,	0	0	0	.	0	0	0	0	0

⇐ whole numbers |

| decimal fractions ⇒

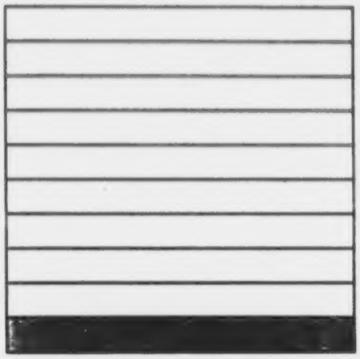
⇑

decimal point

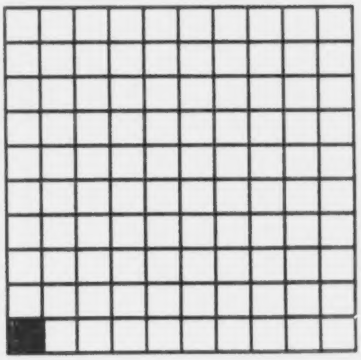
Decimals - The Cube Model

One whole box
1.00

This box is divided into ten parts.
one part = one tenth
.1 (1/10)

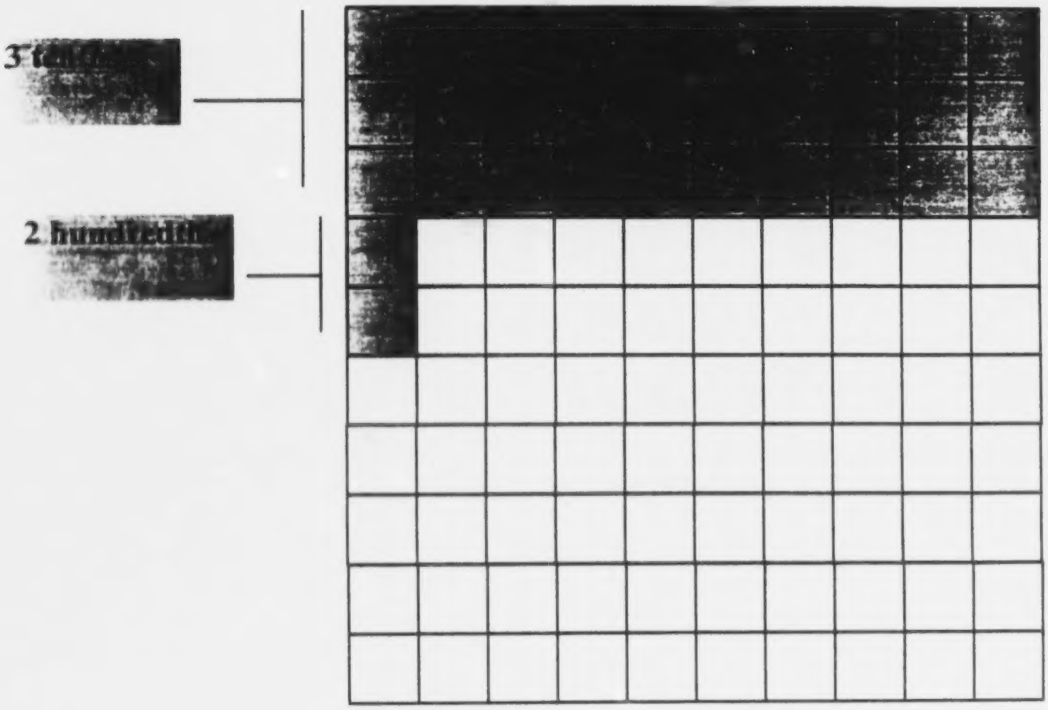


This box is divided into one hundred parts
one part = one hundredth
.01 (1/100)



Cube Model Example

The shaded area represents 0.32 (thirty-two hundredths)


3 tenths
2 hundredths

Each square equals 1 hundredth

10 hundredths equal one tenth

30 hundredths equal 3 tenths

BEST COPY AVAILABLE

Place Value Practice

Write each decimal in words

1. 0.4

2. 0.02

3. 0.723

4. 8.6

5. 75.1234

Write each decimal in numbers

6. **Six tenths**

8. **Nine and one hundred sixty-five thousandths**

7. **Two thousand four hundred twenty-three ten-thousandths**

Unit: Decimal Numbers

Reading and Writing Decimal Numbers

Description	In this lesson, students will learn to read and write decimal numbers using the correct terminology. Students will learn to write decimal numbers using both digits and words. They will also learn to differentiate between the whole and fractional part of decimal numbers. The lesson will also require students to read aloud decimal numbers.
Objectives	*Students will be able to*: ➢ Given two decimal numbers, read the numbers aloud ➢ Given two decimal numbers, write the decimal numbers in digit and/or word form
Prerequisite skills	*Students should*: ➢ Understand the decimal number system ➢ Be able to identify place values for whole numbers ➢ Be able to identify place values for decimal numbers
Technology Utilization	The Reading and Writing module of *Get it in Gear!* The Introduction to Decimals module can be used for students who need a refresher on decimal numbers and place value.
Materials	*GiiG* software and disk, paper and pencil, whiteboard, and markers; Place Value Chart, Remembering Place Value Names, and Cube Model/Example handouts
Teacher to Teacher	**Key concepts and vocabulary:** *decimal number, decimal point, decimal fraction, whole number; mixed decimal numbers place value, place holder, leading zero, reading decimal numbers, writing decimal numbers* ***Time***: approximately 45 minutes for lecture and practice and 45 minutes on computer; minimal setup time Most adult students are familiar with decimal numbers and will have real life examples - use them, but be careful to not put students on the spot! Students are exposed to decimal numbers in many situations on the job and in personal life. It is important for them to read and write decimal numbers accurately to avoid misunderstandings and confusion. Reading and writing decimal numbers is critical to CNC operations emphasize the need to communicate accurately with supervisors and coworkers. Emphasize the need read and write decimal numbers in their personal life as well. The instructor

	should be familiar with the introduction and reading and writing modules in *Get it in Gear!* Be sure to review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 32-33 and 46-47

Purpose	To be able to communicate effectively with co-workers, supervisors, family members, and others students need to read and write decimal numbers accurately. **This skill is particularly important when working with CNC controller panels and machining tools**. When decimal numbers are not read or written accurately, the result may be more downtime, more scrapped parts, and thousands of dollars in machine or tool repair costs. All of these negatively impact workers and the organization. Explain how we use decimals in everyday life and the problems that occur when not used correctly.
Procedures	**Off computer**
	1. Introduce lesson by discussing purpose and objectives. 2. Review necessary prerequisite skills: whole number place value, decimal numbers, decimal number place value, etc. 3. Begin by relating reading and writing decimals to what students already know. For example, have students give examples of real life situations where they have had to read or write decimal numbers (think of money, recipes). Next, discuss problems that may occur because the numbers were read, spoken, or written incorrectly. 4. Demonstrate the process of **reading decimal fractions**. Be sure to give several examples using numbers that have 1-5 decimal places. Include **mixed decimal** numbers (a whole number plus decimal fraction) and emphasize using the word **AND** (not point) when reading the decimal point. Be sure to discuss the importance of pronouncing the **"th"** ending. 5. Have students work in pairs to practice reading decimal numbers aloud. Include several different forms (.043, .0006, 1.2, 2.0, etc.) 6. Demonstrate the process of writing decimal numbers. Start with decimal fractions and progress to mixed decimals. 7. Determine place value of last digit (use the "th" word) 8. Write the number using zeros as place holders if needed. 9. Example: To write thirty-six thousandths as a decimal fraction 1) the "th" word is thousandths; 2) write 36 so that the 6 is in the thousandth place; 3) place a zero in front of 36 as a place holder: answer: **.036**

	10. Explain that students will use the software to practice and learn more about reading and writing decimal numbers. 11. Review topics covered. Be sure to relate to the work environment as you review. Example: plant documents (SPC charts, Hofler report); digital gages (ding ball), CNC panel, paychecks, etc.
Procedures	**On computer**
	Have students launch the *GiiG* program and complete the Reading and Writing Module including all practice problems. Facilitate as needed.

Evaluation / Assessment	Have students research their jobs, newspapers, magazines, etc. and bring in examples of decimal numbers. Using these examples, write ten numbers on the board. Have students identify the place value of the digits and rewrite the decimal numbers in their opposite form. Example: rewrite 9.05 as nine and five hundredths; rewrite six tenths as .6. See Smart Solutions: decimals, fractions, ratios, and percents pages 16-18 for additional assessments.
Resources	➢ Essential Mathematics for Life, Contemporary's Number Power 2, Smart Solutions: decimals, fractions, ratios, and percents ➢ Handouts in Instructor's Guide ➢ *GiiG* Software
Homework	Assign additional practice problems as necessary. See Number Power 2, page 50 and 51. Also use a copy of Hofler report for additional practice.

Sample Hofler Report

Machine Corrections

SUMMARY NO.: HO 16656B	D NO: HOB 8.25 3.55 PINION
ACTUAL FILE NUMBER: 9	PART NUMBER: 1
DATE: 3 May 1997	TIME: 10:07:40
DATA DOWNLOADED ON: 11/3//94	DIFF. ANGLE THEOR.: -13.751

175HC MACHINE SETTING CHANGES
ZERO, FIRST ORDER
PINION - SPREAD BLADE

26.	RADIAL DISTANCE	-.0004 INCHES
27	TILT ANGLE	.011 DEG
28.	SWIVEL ANGLE	-.064 DEG
30.	MACHINE ROOT ANGLE	-.054
32.	SLIDING BASE	.0024
32.	RATIO OF ROLL	.00081
34.	CENTER ROLL POSITION	.004 DEG

PHOENIX CORRECTIONS HAVE BEEN OUTPUT TO FLOPPY DISK

CENTER ROLL POSITION	.0021 IN.
SUM OF THE ERRORS SQUARED	.00000449
SUM OF ERRORS SQUARED (AFTER 1ST)	.000001571

PRESSURE ANGEL	-4.56 MIN.	-.49 MIN
SPIRAL ANGLE	.16 M IN.	-.32 MIN
WARP FACTOR	-4.405 MIN / IN.	-.987 MIN /IN.
RMS ERROR (ORIG.)	.0003 IN.	.0001 IN.
RMS ERR. (AFTER 1ST)	.0002 IN.	.0001 IN.

Unit: Decimal Numbers

Rounding Decimal Numbers

Description	In this lesson, students will learn how to estimate values by rounding numbers. They will learn how to round decimal numbers using the rule of five (5). The rule of five is used to round decimal numbers to the closest whole number and to a decimal place value.
Objectives	*Students will be able to*: ➢ Given a list of decimal numbers, round the numbers to the nearest whole number using the rule of five ➢ Given a list of decimal numbers and the required place value use the rule of five to round the decimal numbers to the correct place value.
Prerequisite skills	*Students should*: Understand the decimal number system Be able to read and write decimal numbers Be able to identify place values of decimal numbers
Technology Utilization	None
Materials	Paper, pencil, place value chart, whiteboard, markers, and handouts.
Teacher to Teacher	**Key vocabulary and concepts** : *estimate, approximate, rounding up, rounding down, accuracy, useful guess.* ***Time***: approximately 45 minutes lecture, 45 minutes practice, and 30 minutes on homework; minimal setup. ➢ Students may not understand why they need to round numbers. Be prepared to relate rounding and estimating. Rounding is not a specific skill for CNC, but can be used as a quick check for calculations. Have students think of how they estimate exact numbers in their personal lives and at work. It is important for students to understand that some estimates need to be more accurate than others depending on the situation. Discuss the usefulness of estimating values. Students must have a good understanding of decimal place value and whole numbers. Watch for students who have problems when the digit in the place to be rounded to is the number 9. Be sure to review the student's pre-test to determine areas of weakness.

Unit pre & post test	Essential Mathematics For Life, Book 7, pp. 32-33 and 46-47
Purpose	Explain that there are times when exact amounts are not necessary (e.g. distance to work, time to complete a task) When this happens, an estimate will be a close approximation or a good guess. Rounding is one way to estimate exact numbers. Explain that understanding how to round numbers will help students estimate accurately, and therefore, saves time and effort on and off the job.

Procedures / Activities	**Off Computer**
	1. Introduce lesson by explaining the purpose and objectives. Review prerequisite skills by asking students what they have learned about decimal numbers and place value. 2. Begin lesson by having students provide examples of situations when they have had to estimate a number (tips, enough money to pay for a bill). Discuss why estimating was useful. Ask students to explain situations where they have used round numbers. 3. Explain how rounding is a technique used to estimate exact values so that the numbers are easier to use. Give examples of when to estimate. Demonstrate the technique of **rounding up or rounding down** using the rule of 5. 4. Demonstrate the procedure for **rounding a decimal number to a whole number** using the tenths place a clue: 1) look at the digit to the right of the tenths place, 3) if it is less than 5, round down; if 5 or above, round up. Write examples on the board and have students suggest answers. 5. Have students practice rounding decimal numbers to a whole number. 6. Demonstrate the procedure for **rounding to an chosen place value**. Emphasize the importance of identifying the correct place value and using the digit to the right as a clue. 1) determine the chosen place value, 2) look at the digit to the right, 3) if it is less than 5, round down if 5 or above, round up. Write examples on the board and have students suggest answers. Include decimal numbers out to five decimal places. 7. Have students practice rounding to a designated place value. Provide numbers (from work or home). Use Practice Rounding Decimal Numbers handout.
	8. Review by asking students to explain what they have learned about estimating and rounding. Provide additional comments to make sure all concepts are covered. Relate discussion to work and real life uses for estimating.

Evaluation /Assessment	Write on board or provide handout listing 10 decimal numbers. Have students round to a whole number or dollar value. Also have students round to designated place values.
Resources	Contemporaries Math Skills that Work Essential Mathematics for Life, Book 7, page 34 Smart Solutions, pages 48-49.
Homework	Have each student identify two situations where estimating would be appropriate. Have them estimate the value using the rounding up or down techniques For rounding to a place value use decimal numbers from previous lessons and randomly assign place values to use.

Practice Rounding Decimals

1. Round to the nearest **tenth**:

0.32 ________ .067 ________ 0.65 ________ 0.81 ________
0.94 ________ .058 ________ 0.76 ________ 0.59 ________

2. Round to the nearest **one hundredth**:

0.321 ________ .0679 ________ 0.652 ________ 0.818 ________
0.943 ________ .0587 ________ 0.764 ________ 0.595 ________

3. Round to the nearest **thousandth**

0.32191 ________ .067982 ________ 0.65237 ________
0.81862 ________ .094344 ________ 0.58799 ________
0.76469 ________ 0.59527 ________ 1.38585 ________

4. Round to the nearest **ten thousandth**:

0.32191 ________ .067982 ________ 0.65237 ________
0.81862 ________ .094344 ________ 0.58799 ________
0.76469 ________ 0.59527 ________ 1.38585 ________

Practice Rounding Decimals

5. Round to the nearest whole number or dollar.

7.058 ________ 6.92 ________ 12.461 ________

902.496 ________ 40.47 ________ $5.69 ________

$45.04 ________ $0.88 ________ $9.20 ________

Unit: Decimal Numbers

Adding and Subtracting Decimal Numbers

Description	In this lesson, students will learn to both add and subtract numbers written in decimal form. The lesson explains the procedures for both adding and subtracting decimal numbers of varying magnitude. In other words, the numbers used as examples and practice problems will range from -9999.9999 to 9999.9999. The lesson will emphasize that adding or subtracting decimal number is very similar to adding and subtracting whole numbers, and will also emphasize the importance of lining up the decimal point. Students will be expected to perform the operations by hand.
Objectives	*Students will be able to*: ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, add them w/o error. ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, subtract them w/o error. ➢ State the rules/procedures for adding and subtracting decimal numbers.
Prerequisite skills	*Students should*: ➢ Be able to add and subtract positive and negative integers ➢ Have a working understanding of the decimal point and decimal numbers ➢ Have a working knowledge of place value ➢ Have an working understanding of adding zeros as place holders (e.g. 2.5 is the same as 2.50 or 2.500).
Technology Utilization	Adding Decimals and Subtracting Decimals modules of *Get it in Gear!* software. They are accessed as tutorials from the tutor button within the CNC simulation.
Materials	*GiiG* software, disk, paper, pencil, calculator, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words are**: *add, subtract, take away, from, minus, plus, decimal point, place value, whole number, positive, negative, decimal number, equals, product, difference, borrow, sum, and place holder.* ***Time:*** 1 hour lecture time and 1 hour on computer (students should skip the problems involving negative numbers at this time); minimal setup. Group work is not necessary. Be prepared for students who understand the material and move quickly. You should become fluent with the *Get it in Gear!* software modules referenced above before using it as an instructional tool. Be

	sure to talk about how adding and subtracting decimals is used when making summary changes on the CNC machines in Dept. 74.1. Get the students to realize how these skills are very critical to making perfect parts. Ask students to think about how they use addition and subtraction of decimals in their own lives (e.g., money). Talk about the benefits of accuracy. Students must have the prerequisite skills listed above. Be sure to review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 32-33 and 46-47

Purpose	Explain that adding and subtracting decimals is critical to the job of an operator of CNC equipment. These machines have decimal readouts and to make adjustments you must be able to add and subtract. Explain that while calculators are a great tool, they should not be a crutch. Lastly, explain that even in everyday life, we must add decimals, like money or food prices.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. 2. Review prerequisites by asking students to explain the decimal point, place value, etc. 3. Begin by pointing out that adding and subtracting decimals is very much like adding and subtracting whole numbers. 4. Demonstrate the steps for adding decimal numbers on the board: 1) Line-up the numbers in a column, lining up the decimal points. Put a decimal point at the end of any whole number. 2) Add zeros if necessary as place holders. 3) Add as with whole numbers. 4) Bring the decimal point straight down into the answer. Example 10.25 + 0.1025 5. Demonstrate these steps using numerous examples. Use negative numbers as well. Example –2.525 + 0.750 6. Write problems on the board, and ask students to walk you through the steps. Guide them as necessary. 7. Demonstrate the steps for subtracting decimal numbers on the board: 1) Line-up numbers in a column, lining up the decimal points. Put a decimal point at the end of any whole number. 2) Add zeros if necessary as place holders. 3) Subtract as with whole numbers. 4) Bring the decimal point straight down into the answer. 8. Demonstrate these steps using numerous examples. Use two numbers in the equation, and use numbers as large as 9999.9999.

	9. Write problems on the board, and ask students to walk you through the steps. Guide them as necessary. Use negative numbers too. 10. Now its time for the students to practice on their own. Put a few addition and subtraction problems on the board and give them 15 minutes max. to answer them. Check their answers.

Procedures	**On computer**
	Have the students launch *GiiG!* (note see the section How to use *GiiG!* for technical assistance). Direct the students to: ➢ Either the Adding or Subtracting Decimals modules on the main menu. This launches the CNC summary change simulation. ➢ Work through the first three problem sets (21 problems). (Remember, an answer must be provided for the 7th and last problem w/in a set in order to continue to the next set). ➢ Access the tutor if they need help or make many mistakes. ➢ Use the notepad to take notes about what they learned.

Evaluation / Assessment	Have students research their jobs, newspapers, magazines, etc. and bring in examples of decimal numbers. Using these examples, write ten numbers on the board. Have students identify the place value of digits and rewrite the decimal numbers in their opposite form. Example: rewrite 9.05 a. nine and five hundredths and rewrite six tenths as .6. See Smart Solutions pages 16-18 for additional assessments.
Resources	• Write on the board some sample settings from the CNC panel (just like in the software). Ask the students to give you a reasonable offset value, similar to those from the Hofler report. Ask the students how to do the addition or subtraction. Write on the board as they prompt you. Reemphasize how adding and subtracting decimals is vital to CNC operation. Extend their minds into their own lives and again ask how they add and subtract decimals outside the plant. *GiiG!* Software
Homework	Try this! Look inside your refrigerator and cabinets at home and write down the approximate prices of the food you see. Add them up. Subtract that amount from your monthly salary. Try this: Look up how the ancient Chinese use an abacus to add and subtract. Write a paragraph about it!

Sample Hofler Report

Machine Corrections

SUMMARY NO.: HO 18336
ACTUAL FILE NUMBER: 68
DATE: 22 May 1996
DATA DOWNLOADED ON: 1996

D NO: HOB 9.25 4.1 GEAR
PART NUMBER: 4.10-9.25-3
TIME: 15:38:29
DIFF. ANGLE THEOR.: -3.884

175HC MACHINE SETTING CHANGES
ZERO, FIRST ORDER
PINION - SPREAD BLADE

41.	VERTICAL	.0003 INCHES
42.	HORIZONTAL	-.0008 INCHES
43.	SWIVEL ANGLE	-.0007 INCHES
30.	MACH CENTER TO CROSS PT	-.007 DEG

PHOENIX CORRECTIONS HAVE BEEN OUTPUT TO FLOPPY DISK

MEASURED TOOTH THICKNESS	0 IN.
SUM OF THE ERRORS SQUARED	.00000048
SUM OF ERRORS SQUARED (AFTER 1ST)	.00000044

PRESSURE ANGEL	-1.7 MIN.	-1.51 MIN
SPIRAL ANGLE	.01 M IN.	-.28 MIN
WARP FACTOR	-.931 MIN / IN.	-.739 MIN /IN.
RMS ERROR (ORIG.)	.0001 IN.	.0001 IN.
RMS ERR. (AFTER 1ST)	.0001 IN.	.0001 IN.

Unit: Decimal Numbers

Multiplying Decimals

Description	In this lesson, students will learn to multiply numbers written in decimal form. The lesson explains the procedures for multiplying decimal numbers of varying magnitude. In other words, the numbers used as examples and practice problems will range from -9999.9999 to 9999.9999. The lesson will emphasize that multiplying decimal numbers is very similar to multiplying whole numbers, and will also emphasize the importance of counting the number of decimal places. Students will be expected to perform the operations by hand.
Objectives	*Students will be able to:* ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, multiply them w/o error. ➢ State the rules/procedures for multiplying decimal numbers.
Prerequisite skills	*Students should:* ➢ Be able to add and multiply whole numbers. ➢ Have a working understanding of the decimal point and decimal numbers. ➢ Have a working knowledge of place value. ➢ Have an working understanding of adding zeros as place holders (e.g., 2.5 is the same as 2.50 or 2.500). ➢ Have a working understanding of decimal place(s).
Technology Utilization	None
Materials	Paper, pencil, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words are:** *add, multiply, times, decimal place, plus, decimal point, place value, whole number, decimal number, equals, product difference, borrow, sum, and place holder.* ***Time:***. approximately 1 hour lecture and minimal setup. Group work can be used. Be prepared for students who forget how to multiply whole numbers. Be sure to mention that although multiplication of decimals is not used in the operation of a CNC, it is a very important life skill. Ask students to think about how they multiply decimals in their own lives (e.g., rate x time). Talk about the benefits of accuracy. Students must have the prerequisite skills listed above. Be sure to review the student's pre-test to determine areas of weakness.

Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 32-33 and 46-47

Purpose	Explain that multiplying decimals is used on the job for things like determining pay. Explain that while calculators are a great tool, they should not be a crutch. Lastly, explain that even in everyday life, we must multiply decimals, like figuring out the tip at a restaurant.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. 2. Review prerequisites by asking students to tell you what the decimal point is, place value, etc. 3. Begin by pointing out that multiplying decimals is very much like multiplying whole numbers. 4. Demonstrate the steps for multiplying decimal numbers on the board: 1. Line numbers up in a column, flush on the right. 2. Multiply as with whole numbers. 3. Count the number of decimal places in both numbers and add them together. 4. Count off this total number of decimal places in the answer. Move the decimal point from right to left. Example: 45.05 x 5.5 5. Demonstrate these steps using numerous examples. Use two numbers in the examples. 6. Write some problems on the board, and ask students to walk you through the steps. Guide them. 7. Now its time for the students to practice on their own. Put a few multiplication problems on the board and give them 15 minutes max. to answer them. Check their answers. 8. Direct the students to take notes about what they learned.

Procedures	**On computer**
	None

Evaluation / Assessment	Write on the board some problem solving questions. Ask the students how to solve the problem (which requires multiplication of decimals). Example: If you earned 21.50/hour, how much would you make after 37.5 hours? Write on the board as they prompt you. Reemphasize how multiplying decimals is common in everyday life. Extend their minds into their own lives and again

	ask how they multiply outside the plant. Now its time for a group activity. Break the class up into pairs, and assign Activity 5 (page 38 of the *Essential Mathematics for Life* ***Instructor Guide***).
Resources	
Homework	Try this! Suppose Joe makes $1.25 per minute, and Sally makes $1.45 per minute. How much does each make per hour? Per week? Per month (assume 4 weeks per month)? Per year? How much more per year does Sally make (remember how to subtract!) ? What are some different ways you could solve the problem?* Also assign Activity 6 (page 39 of the *Essential Mathematics for Life* ***Instructor Guide***). (*Teacher to teacher: in other words, you could take the weekly salary and multiply by 52, or you could multiply it by 4 and then multiply that answer by 12).

Unit: Decimal Numbers

Dividing Decimal Numbers

Description	In this lesson, students will learn to divide numbers written in decimal form. The lesson explains the procedures for dividing decimal numbers of varying magnitude. In other words, the numbers used as examples and practice problems will range from -9999.9999 to 9999.9999. The lesson will emphasize that dividing decimal numbers is very similar to dividing whole numbers, and will also emphasize the importance of moving the decimal point. Students will be expected to perform the operations by hand.
Objectives	*Students will be able to*: ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, divide them w/o error. ➢ State the rules/procedures for dividing decimal numbers.
Prerequisite skills	*Students should be able to*: ➢ Add, subtract, multiply and divide whole numbers. ➢ Have a working understanding of the decimal point and decimal numbers. ➢ Have a working knowledge of place value. ➢ Have an working understanding of adding zeros as place holders (e.g., 2.5 is the same as 2.50 or 2.500). ➢ Have a working understanding of decimal place(s).
Technology Utilization	None
Materials	Paper, pencil, calculator, whiteboard and markers
Teacher to Teacher	***Time:***. 1 hour lecture and nominal setup . Group work can be used **Key concepts and vocabulary words are*:*** *add, divide, subtract, multiply, times, positive, negative, decimal place, plus, decimal point, place value, whole number, decimal number, equals, quotient, dividend, digit, divisor, difference, borrow, sum and rounding.* Be prepared for students who forget how to divide whole numbers. Be sure to mention that although division of decimals is not used in the operation of a CNC, it is a very important life skill. Ask students to think about how they divide decimals in their own lives (e.g., figuring out miles per gallon). Talk about the benefits of accuracy. Students must have the prerequisite skills listed

	above. Be sure to review the student's pre-test to determine areas of weakness. The Jeopardy game must be set up before the class (see evaluation activities).
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 32-33 and 46-47

Purpose	Explain that dividing decimals is used on the job for things like determining pay. Explain that while calculators are a great tool, they should not be a crutch. Lastly, explain that even in everyday life, we must divide decimals, like figuring out an hourly rate.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. 2. Review prerequisites by asking students to explain the decimal point, place value, etc. 3. Begin by pointing out that dividing decimals is very much like dividing whole numbers. 4. Demonstrate the steps for dividing decimal numbers on the board: 1. Set up the problem (e.g. $30 \div 2.5$ is written $2.5\sqrt{30.5}$. 2. If necessary, make the divisor a whole number by moving the decimal point to the right of the last digit. 3. In the dividend, move the decimal point to the right the same number of places. 4. Now place a decimal point directly above in the answer (quotient). 5. Divide as if the divisor and dividend are whole numbers. 5. Demonstrate these steps using numerous examples. 6. Write problems on the board, and ask students to walk you through the steps. Guide them. 7. Now its time for the students to practice on their own. Put a few division problems on the board and give them 15 minutes max. to answer them. Check their answers. (Maybe hand out a worksheet) 8. Direct the students to take notes about what they learned.
Procedures	**On computer**
	None

Evaluation / Assessment	Write on the board some division problems. Ask the students how to solve them. Write on the board as they prompt you. Reemphasize how dividing decimals is common in everyday life. Extend their minds into their own lives

	and again ask how they divide outside the plant. This is the last lesson in the unit, so lets play a game! Divide the students up into three teams. Put a problem on the board relating to any lesson in the Decimals unit. The team who gets the correct answer first gets a point. **OR**...do a math Jeopardy game. The categories will relate to the six lessons in this unit. Each 'square' (e.g., "adding decimals for $300") will contain a math problem. If the team gets it right, they get to choose another (just like Jeopardy the game show) and rack up points. If they miss it, the turn goes to the next team. Set this game up ahead of time.
Resources	Essential Mathematics for Life, Book 7.
Homework	Assign the life skill exercise on gas mileage (page 42 of the *Essential Mathematics for Life **Book** 7*). Also: Try this! Suppose Joe got a paycheck for $525.75 for 40.75 hours of work, and Sally got a paycheck of $495.25 for 33.33 hours of work. Who makes more per hour?

Positive & Negative Numbers

Unit: Positive and Negative Numbers

Adding and Subtracting Positive and Negative Numbers

Description	In this lesson, students will learn to add and subtract both positive and negative numbers written as whole numbers and in decimal form. The lesson explains the procedures for both adding and subtracting positive and negative numbers of varying magnitude. In other words, the numbers used as examples and practice problems will range from -9999.9999 to 9999.9999. Decimal numbers will be used after students feel comfortable with the whole number calculations. The lesson will emphasize that adding or subtracting positive and negative numbers is the same as moving along the number line. Students will be expected to perform the operations by hand.
Objectives	*Students will be able to:* ➢ Given two whole numbers ranging from -9999 to 9999, add them w/o error. ➢ Given two whole numbers ranging from -9999 to 9999, subtract them w/o error. ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, add them w/o error. ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, subtract them w/o error. ➢ State the rules/procedures for adding and subtracting positive and negative numbers. ➢ Demonstrate the use of the number line for adding and subtracting positive and negative numbers
Prerequisite skills	*Students should:* ➢ Be able to add and subtract positive whole numbers. ➢ Be able to add and subtract positive decimal numbers. ➢ Have a working understanding of the decimal point and decimal numbers. ➢ Have a working knowledge of place value. ➢ Have an working understanding of adding zeros as place holders (e.g., 2.5 is the same as 2.50 or 2.500). ➢ Be able to use the number line. ➢ Have a working understanding of the concept of negative and also negative numbers.

Technology Utilization	The Adding Decimals and Subtracting Decimals modules of *Get it in Gear!* are accessed using the tutor button from within the CNC simulation. The Combining Positive Negative Numbers module is accessed from the Main Math Menu.
Materials	*GiiG* software, disk, paper, pencil, calculator, whiteboard, and markers.
Teacher to Teacher	**Key concepts and vocabulary words:** *add, subtract, take away, from, minus, plus, decimal point, place value, whole number, decimal number, equals, place holder, negative, positive, sign, number line, move, product, difference, borrow, sum, zero.* ***Time***: 1 hour lecture, 1 hour on computer, and nominal setup. Group work is not necessary. Be prepared for students who understand the material and move quickly. You should become fluent with the *Get it in Gear!* software modules referenced above before using it as an instructional tool. Be sure to talk about how adding and subtracting positive and negative decimals is required to make summary changes on the CNC machines. Get the students to realize these skills are very critical to the job and to making perfect parts. Ask students to think about how they use negative numbers in their own lives (e.g., balancing a checkbook or going in the "red"). Talk about the benefits of accuracy. Students must have the prerequisite skills listed above before beginning this lesson. Be sure to review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 194-195 and 212

Purpose	Explain that dividing decimals is used on the job for things like determining pay. Explain that while calculators are a great tool, they should not be a crutch. Lastly, explain that even in everyday life, we must divide decimals, like figuring out an hourly rate.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. 2. Review prerequisites by asking students to explain (e.g., "What is a negative number?") or demonstrate the skill (e.g., "How would I add 5.2 and 0.0075 ?"). Review any prerequisite skills not mastered. 3. Begin by pointing out that adding and subtracting positive and negative numbers is the same as moving along the number line. 4. Draw the number line on the board, emphasizing the location of positive

and negative numbers in relationship to the zero point.

5. Use the number line to demonstrate the steps for adding positive whole numbers on the board. Example 5 + 7
6. Use the number line to demonstrate the steps for adding a negative integer to a positive integer. Example 5 + (–7). Demonstrate using many examples with numbers no greater (or less than) 20 (or –20).
7. Use the number line to demonstrate the steps for adding two negative integers. Example (–5) + (–7). Demonstrate using many examples using numbers no greater (or less than) 20 or (–20).
8. Put problems on the board such as 10 + (–8), (–3) + 11, and (–12) + (–4). Ask students to walk you through the steps. Guide them.
9. Attempt to get the students to calculate the problems w/o the number line.
10. Now its time for the students to practice on their own. Put a few addition problems on the board and give them 10 minutes max. to answer them. Check their answers. Once students are comfortable adding positive and negative integers, you are ready to move onto subtraction.
11. Draw the number line on the board, emphasizing the location of positive and negative numbers in relationship to the zero point.
12. Use the number line to demonstrate the steps for subtracting positive whole numbers on the board. Example 9 – 7. Make sure the answers to the examples you use first are all positive. Then demonstrate some of the steps for which the answer is negative, such as 7 – 9.
13. Use the number line to demonstrate the steps for subtracting two negative integers. Example (–5) – (–7). Demonstrate using many examples using numbers no greater (or less than) 20 or (–20). Explain the rules for subtracting when negative numbers are involved: *minus a positive equals plus a negative*; and *minus a negative equals plus a positive*
14. Now its time for the students to practice on their own. Put a few addition problems on the board and give them 15 minutes max. to answer them. Check their answers. Recognize that adding and subtracting positive and negative numbers may not come naturally to some, so be prepared to demonstrate more problems on the board, and to ask students to do more practice problems. Attempt to get the students to calculate the problems w/o the number line. Also use some practice problems with four digit integers.
15. At this point, no decimal number have been used. Remind students that adding and subtracting *positive* decimal numbers has been done before, but check to see that all remember how.
16. Now bring it all together by demonstrating and practicing adding and subtracting positive and negative decimals.

Procedures	**On computer**
	Have the students launch *GiiG!* (note see the section How to use *GiiG!* for technical assistance). Direct students to: ➢ Positive and Negative Numbers module on the main menu. This launches the CNC summary change simulation. ➢ Work through the 4th, 5th, and 6th problem sets (21 problems). (To skip a problem set, direct students to answer the last problem. This will activate the Next button. They must answer the last problem in problem sets one, two and three in order.

Evaluation / Assessment	Write on the board sample settings from the CNC panel (just like in the *GiiG!* software). Ask the students to give you a reasonable offset value, like would come from the Hofler report. Ask the students how to do the addition or subtraction. Complete the steps on the board as they prompt you. Reemphasize how adding and subtracting positive and negative decimals is vital to CNC operation. Extend their minds into their own lives and again ask how they add and subtract decimals outside the plant.
Resources	*GiiG* Software
Homework	Try this! Checkbook exercise. Start out with $100.00. Record the new balance for each of the debits and credits. Balance Opening balance $100.00 Check 101 $50.89 Check 102 $45.52 Deposit $25.00 Check 103 $75.00 Check 104 $13.33 Deposit $130.00 Check 105 $66.06 Bounce check fee $12.00 Interest $0.95

Adding Positive and Negative Numbers Practice

1. -4
   +3

2. -3
   +4

3. -7
   +-5

4. -5.5
   +7

5. -6
   +-3

6. -7
   +4

7. 11
   +-5

8. -9.2
   +-7

9. 0+ (-5) ____________

10. 3 + (-1) ____________

11. -4 + (-4) ____________

12. -4.5 + (-9.5) ____________

13. -5 + 7.4 ____________

14. -11 + 0 ____________

15. -30 + (-60) ____________

16. 112 + (-210) ____________

Subtracting Positive and Negative Numbers Practice

1. $\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$ 2. $\begin{array}{r} 3 \\ -4 \\ \hline \end{array}$ 3. $\begin{array}{r} 7 \\ -5.5 \\ \hline \end{array}$ 4. $\begin{array}{r} 5.5 \\ -7 \\ \hline \end{array}$

5. $\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$ 6. $\begin{array}{r} 3 \\ -4 \\ \hline \end{array}$ 7. $\begin{array}{r} 7 \\ -5.5 \\ \hline \end{array}$ 8. $\begin{array}{r} 5.5 \\ -7 \\ \hline \end{array}$

9. -4 - (-7) ____________ 10. 3 -1 ____________

11. -1 -(-1) ____________ 12. -2 -5 ____________

13. 11 -9 ____________ 14. -24 -(-75) ____________

15. -25 -(-90) ____________ 16. 100 -(-205) ____________

Unit: Positive and Negative Numbers

Multiplying and Dividing Positive and Negative Numbers

Description	In this lesson, students will learn to multiply and divide both positive and negative numbers. The lesson explains the procedures for both multiplying and dividing positive and negative numbers of varying magnitude. In other words, the numbers used as examples and practice problems will range from -9999 to 9999. Decimal numbers will ONLY be used if students feel very comfortable with the whole number calculations and if time allows. The lesson will emphasize remembering the rules for multiplying and dividing positive and negative numbers. Students will be expected to perform the operations by hand.
Objectives	*Students will be able to:* ➢ Given two whole numbers ranging from -9999 to 9999, multiply them w/o error. ➢ Given two whole numbers ranging from -9999 to 9999, divide them w/o error. ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999 to multiply them w/o error. ➢ Given two numbers written in decimal form ranging from -9999.9999 to 9999.9999, divide them w/o error. ➢ State the rules/procedures for multiplying and dividing positive and negative numbers.
Prerequisite skills	*Students should:* ➢ Be able to multiply and divide positive whole numbers. ➢ Be able to multiply and divide positive decimal numbers. ➢ Have a working understanding of the decimal point and decimal numbers. ➢ Have a working knowledge of place value. ➢ Have an working understanding of adding zeros as place holders (e.g., 2.5 is the same as 2.50 or 2.500). ➢ Be able to use the number line. ➢ Have a working understanding of the concept of negative and also negative numbers.
Technology Utilization	None
Materials	Computer, disk, paper, pencil, calculator, whiteboard and markers.

Teacher to Teacher	**Key concepts and vocabulary words:** *add, subtract, multiply, divide, take away, from, minus, plus, decimal point, place value, whole number, decimal number, equals, place holder, negative, positive, sign, number line, move, zero, product, difference, borrow, sum.* ***Time:*** 2 hours lecture time and nominal setup. Group work is not necessary. Be prepared for students who understand the material and move quickly. Students must have the prerequisite skills listed above before beginning this lesson. Students should be able to multiply and divide decimals already, so this lesson should basically be about the rules for the multiplying and dividing when negative (and positive) numbers are involved. Be sure to review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 194-195 and 212

Purpose	Know how to multiply and divide positive and negative numbers will allow you to move ahead into more advanced math topics.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. 2. Review prerequisites by asking students to explain (e.g., "What is a negative number?") or even to demonstrate the skill (e.g., "How would I multiply 5.2 and 0.75 ?"). Review any prerequisite skills not mastered. 3. Begin by pointing out that before we just used positive numbers, and now we will learn what to do when negative numbers are used as well. 4. Explain that it's really simple to do. On the board, write the rule for multiplying and dividing two negative numbers (the sign is always positive). 5. Show some examples. Example (–0.5) x (– 0.7). 6. On the board, write the rule for multiplying and dividing a positive and a negative number (the sign is always negative). Example 5 x (–7). Demonstrate both rules using many examples with numbers no greater (or less than) 9999.9999 (or –9999.9999). 7. Demonstrate both rules using many examples with numbers no greater (or less than) 9999.9999 (or –9999.9999). 8. Stress the importance of remembering the two rules, and how simple it all really is because they already know how to multiply and divide. 9. Now its time for the students to practice on their own. Put a few problems on the board (mix of decimals and whole numbers) and allow 20 minutes

	to answer them. Check their answers. Perhaps make it challenging by offering a prize to the first one to finish with all the correct answers.

Procedures	**On computer**
	None

Evaluation / Assessment	Write on the board some multiplication and division problems with positive and negative numbers. Ask the students to tell you what the sign of the answer will be.
Resources	
Homework	

Percents

Unit: Percents

Converting Decimals and Percents, Percent Calculations

Description	In this lesson, students will get a brief overview of percents and how they relate to whole numbers, decimals and fractions. This lesson will explain the procedure to convert decimals to percent and vice-versa. It will also concentrate on certain percent calculations. The students will perform the calculations by hand.
Objectives	*Students will be able to:* ➢ Provide a working definition of percent and also briefly explain their relationship to decimals and fractions. ➢ Given a specific type of percent calculation problem with an unknown, find the unknown without error. ➢ Explain or state steps necessary to convert a decimal to a percent and vice-versa.
Prerequisite skills	*Students should:* ➢ Have an understanding of decimal numbers, whole numbers and fractions. ➢ Be able to add, subtract, multiply and divide all the above. ➢ Have a basic recognition of the % symbol and related experiences with % in their personal lives. ➢ Have a working understanding of multiplying with zeros in problems. ➢ Understand place value and concept of moving decimals.
Technology Utilization	None
Materials	Computer, disk, printer, paper, pencil, calculator, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words:** *percent, move decimal to the right, move decimal to the left, parts of a whole, relation to decimal numbers, relation to fractions, multiplying dividing, working with zeros, common fraction to percent* ***Time:*** approximately 1 hour lecture time and nominal setup. This lesson has the flexibility to incorporate group work. They may take estimated statistics in an effort to mentally attach percentages to work related questions. There will be some students that will recall this information quickly so in order to keep their interest they should be called upon to explain the key concepts in their lesson. Spur a discussion on the percentage of human error in the plant and how it affects the total production process. There are many ways and directions the conversation can go. Help them to mentally attach percentages to their job. Students must have the prerequisite skills above.

	Review the student pretest to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp. 69-70 and 102-103

Purpose	Explain the importance of percent estimations and statistics for determining productivity. The job they perform has a percentage attached to it and in turn that percentage is grouped. All the other statistics and this creates a measure of performance. They can use percentages to measure other personal performances or assist them in other personal activities. Ask students if they have found use of percentages on their jobs and at home.
Procedures	**Off computer**
	1. Ask students what they know about percents. Write student comments on the board. 2. Begin to fill in the gaps: ➢ State the objectives and purpose of this lesson. ➢ Review prerequisite skills needed. ➢ Have students type in this initial information in the notepad and all subsequent information put on the board. 3. Explain percent including a definition and examples. 4. Explain how percents relate to decimals and fractions. Use place value help and understanding. 5. Show steps to change a percent to a decimal and to change a decimal to a percent. Use several examples. Include examples related to the plant floor. 6. Put some problems on the board and have students walk you through the steps to solve them. 7. Define percent and explain its relation to decimals and fractions. ➢ Convert percent to decimal. ➢ Convert decimal to percent. 8. Explain the steps to change a fraction to a percent. Use several common examples. 9. Explain the reasons for order of operations. Give the phrase: "Please excuse my dear Aunt Sally " to help them remember the order and the operations. Give several example problems. 10. Explain the steps to change a percent to a fraction and to find the percent of a number. Use several common examples. 11. Put several problems on the board. Have student walk you through the steps verbally in each group. ➢ Change fraction to percent. ➢ Change percent to fraction. ➢ Find percent of a number.

	➢ Find unknown - both directions. ➢ Usage of the check. 12. Group students by rows. Have them solve individual group worksheets. The worksheets should have different production statistics from 3 different plants. Ask students to provide sample numbers. Each group has to determine which plant is the one to close, leave open, and give a bond to its employees. The group with the correct answer in the 25 minute time period gets 1 more point toward the grand prize. (A trip to Lake Tahoe?) 13. Explain the steps to divide like, proper fractions. Explain the reciprocal and change of operation steps. Use examples. 14. Explain the steps to divide unlike, proper fractions. Use several examples. 15. Give the post test.
Procedures	**On computer**
	None

Evaluation / Assessment	Examine the group project and check notes. Check the homework. Have each student write a brief explanation of what this lesson was all about.
Resources	Essential Mathematics for Life, Book 7 pages 71, 74, and 76-79.
Homework	Have students find examples and give a brief explanation of how percentages work in the census, stock market, recipes, plant production, sales, taxes, etc.

Percent Practice

Convert the following percents to decimal numbers. Example 25% = .25

1. 54% ____________
2. 3% ____________
3. 20% ____________
4. 15% ____________
5. 10% ____________
6. 97% ____________
7. 60 percent ____________
8. 5 percent ____________

Convert the following decimal numbers to percents. Example .50 = 50%

9. 0.45 ____________
10. 0.88 ____________
11. 0.02 ____________
12. 0.15 ____________
13. 0.63 ____________
14. 0.50 ____________
15. 4 hundredths ____________
16. 25 hundredths ____________

Convert the following percent to a fraction. Example .20% = $\frac{1}{5}$

17. 5% ____________
18. 15% ____________
19. 4% ____________
20. 25% ____________
21. 12% ____________
22. 10% ____________
23. 75% ____________
24. 50 hundredths ____________

Convert the following fraction to a percent. Example $\frac{1}{2}$ = 50%

25. $\frac{1}{4}$ ____________
26. $\frac{1}{5}$ ____________
27. $\frac{1}{10}$ ____________
28. $\frac{3}{4}$ ____________

25 % of 100 ____________

30. 60% of 15 ____________

◆

Measurements and Statistics

◆

Unit: Measurements and Statistics

Average (Mean), Mode, Median, and Range

Description	In this lesson students will learn how to use basic statistics. They will learn to calculate the mean, mode, and median. This lesson will also introduce students to the range as a measure of variation. The procedure for calculating the range is presented along with examples of how the range is used in the workplace.
Objectives	*Students will be able to:* ➢ Given a set of data, describe mean, mode, median, and range. ➢ Given two sets of numbers, calculate the mean, mode, median, and range.
Prerequisite skills	*Students should be able to:* ➢ Add and subtract decimal numbers. ➢ Add and subtract positive and negative numbers. Divide whole and decimal numbers.
Technology Utilization	The *Get it in Gear!* Averages and Ranges module can be accessed through the tutor button within the average and range simulation. The module contains sections on averages and ranges only.
Materials	Computer, *GiiG* software, disk, paper, pencil, calculator, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words:** *average, mean, mode, median, set, data, statistics, range.* ***Time:*** 1 hour lecture and 1 hour on computer; set-up is nominal. Realize many students may not like the idea of studying statistics. They are probably familiar with the term average, but not necessarily the mean. Suggest that statistics is simply way of looking at or describing a group of numbers. Point out that having a knowledge of basic statistics is useful for many jobs in the plant. For example, quality control (QC) and statistical process control (SPC) both use statistics. Use the Average and Range Chart from the plant as a real-world application. You may want to begin the lesson by surveying students for information on the number of people in their families, or heights and ages of students. Put the numbers on the board and ask how they would describe the group of numbers. Watch out for students who interchange the terms mean, median, and mode. Familiarize yourself with the Averages and Ranges Module before having students use the *GiiG* software. Be sure to review the student's pre-test to determine areas of weakness.

Unit Pre & Post test	Essential Mathematics For Life, Book 4, pp. 133-134 and 149-150
Purpose	The mean, median, and mode are basic statistics used to analyze or describe a group of numbers. Explain that sometimes it is useful to have only one number that describes an entire group of numbers. The range is used to describe the amount of variation within a group of numbers. This lesson will help students understand the difference between each of these terms and how to calculate the statistics. Basic statistics are used in manufacturing as part of quality control.
Procedures	**Off computer**
	1. Help students recall procedures for adding, subtracting, and dividing whole numbers; positive numbers, negative numbers; and decimal numbers. 2. Begin lesson by asking students to give examples of averages (bowlers, baseball players, salaries for jobs, etc.) Discuss what those numbers really mean. Point out that they are already familiar with averages and that the mean is another word for average. Explain that the terms average and mean are used interchangeably. 3. Write a group of numbers on the board. Define the term *mean* (arithmetic average of the data), and demonstrate the procedure: ➢ sum the group of numbers ➢ divide by the number of values in the group. Point out that the mean does not have to be a member of the group. Also define data and set, terms that are often used when discussing statistics. Work through the example on the board. 4. Define the term *mode*: the number or item that appears most often. Using the same example, demonstrate the procedure for determining the mode. Explain that the mode is always a member of the set of data. Work through the example on the board. 5. Define the term *median*: the number in the middle when the data are arranged in order, and demonstrate the procedure. Use a data set that is even and one that is odd and demonstrate procedure for calculating the mean of the two middle numbers. Point out that the median is not always a member of the group. Work through the example on the board. 6. Have students practice calculating basic statistics using the survey data collected at the beginning of class. If data was not collected at the beginning, do so now. Have students calculate the mean, mode, and median for each group of data. Provide assistance as necessary. 7. Define the term range: difference between the smallest and largest number

	within a set. Demonstrate the procedure for finding the range. Point out that range is sometimes called distance. Work through an example on the board. Use numbers from an actual average and range chart. 8. Have students practice calculating the range using previous sample data. Explain that students will use the *GiiG* software to practice and learn more about average and range. 9. Review with students what they have learned about basic statistics. Include definitions and procedures. Provide additional comments to make sure all concepts are understood. Relate discussion to work and real life uses of statistics.
Procedures	**On computer**
	➢ Have students launch *GiiG* and work through the Average and Range module. This module is accessed through the tutor button. ➢ In order to complete the simulation, students must answer the last question to move to the next screen. Students may use the notepad for taking notes. Their notes can be printed and used for review later. ➢ Review the section How to use *GiiG* for technical assistance.

Evaluation / Assessment	Survey students to find out about data of interest to the group. Record the numbers on the board and have students find the mean median mode, and range of the set of data.
Resources	➢ Essential Mathematics for Life, Book 4: Graphs, Measurements and Statistics; pages 144 -145, 147-148. ➢ Average Practice handout ➢ *GiiG* Software
Homework	Try having each students locate examples of data sets in the newspaper, at home, at work, etc. Use the data collected to calculate the mean median, mode, and range.

Average(Mean) Practice

1. Tim's production of oil pans for the week was:

Monday	98
Tuesday	101
Wednesday	142
Thursday	158
Friday	139

What was his average for the week? ____________

2. On her delivery route, Debbie used

8 gallons of gas on Monday,

10 gallons of gas on Tuesday,

9 gallons of gas on Wednesday,

14 gallons of gas on Thursday,

[redacted] 8 gallons of gas on Friday

What was the average amount of gas used daily? ____________

3. The Advise Company had sales of $103 million in 1990, $142 million in 1991, $98 million in 1992, $112 million in 1993, $138 million in 1994, and $156 million in 1995.

What is their average sales from 1990 to 1995? ____________

What is their average sales from 1990 to 1992? ____________

What is their average sales from 1993 to 1995? ____________

4.

◆

Geometry

◆

Unit: Geometry

Angles

Description	In this lesson, students will learn about angles, and the measurement of angles (i.e. degrees). Only the basics of angles will be presented, such as the parts of an angle, and that angles are measured by degrees. Topics such as obtuse, acute, vertical angles, minutes, seconds, etc. will NOT be discussed.
Objectives	*The student will be able to:* ➢ Given an angle, label its parts (i.e., sides, vertex). ➢ Given various types of units of measurement (e.g., inch, meter, liter). identify which is used for measuring angles (i.e., degree). ➢ Write the proper symbol for degree. ➢ Define the term degree. ➢ Draw an arc to show which of the two possible angles is being referred to. ➢ Explain that a circle is 360°, and that an angle is part of a divided circle.
	Students should: ➢Be able to draw a circle. ➢Be able to draw a line. ➢Have a working understanding of measurement (measuring).
Technology Utilization	None
Materials	Paper, pencil, calculator, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words:** *angle, line, point, sides, vertex, symbol, degree, whole, part.* ***Time***: approximately 1 hour lecture and nominal setup. Group work is not necessary. Be prepared for students who understand the material and move quickly. Students must have the prerequisite skills listed above before beginning this lesson. Be sure to review the student's pre-test to determine areas of weakness.

Unit Pre & Post test	Essential Mathematics For Life, Book 7, pp.125 and 157

Purpose	The CNC panel includes a number of measurements pertaining to the gear or pinion being cut. Some of these measurements – such as the A, B, C (or V) axes – are in degrees. Having an understanding of what degrees and angles are all about will help you understand more about what the machine is doing.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. Review prerequisites by asking students to tell you what they mean (e.g., "What are some common units of measure?") or even to demonstrate the skill (e.g., "Draw a circle"). Review any prerequisite skills not mastered. 2. Begin by pointing out that most things we measure, such as a the desk, or even a person, is in feet or meters. Ask a student to stand and have another measure how tall she/he is with a tape measure. Continue to explain that not everything is measured like a straight line, and that angles fall in that category. 3. Draw an angle on the board and explain that it is the formation of two straight lines at a point. Draw some more angles of various sizes. Explain that the two lines of an angle are called the sides, and that the point at which they meet is called the *vertex*. Make sure the students comprehend that the size of the angle makes no difference: sides are sides and vertexes are vertexes. 4. Demonstrate that angles are like parts of a divided circle. Use a pizza as an example. Each slice represents an angle. Ask students if pizza slices are always the same size. No they are not; pizzas (and pies too) do not always have slices of the same size. Draw two pizza slices, the arc of one greater than the other. Ask students how the pizza slices would be measured? In other words, how do you measure an angle? 5. Explain that the size of an angle depends only on the opening between its sides. This opening is measured in units called degrees. Explain that an arc is used to show the angle referred to. Draw a pizza pie, and draw the two slices. Show that the angles of the two slices are measured in units called *degrees*. (If some ask how, explain the tool is called a protractor). Draw an arc on the two slices to show the angle being measured. 6. Repeat: draw a circle, and explain it is the whole. Ask if anybody knows how many degrees makes a circle. The answer is 360°. Reiterate the point that a circle is 360°. Draw one angle (or slice). Ask the students to identify the sides and the vertex. Demonstrate the use of the arc symbol.

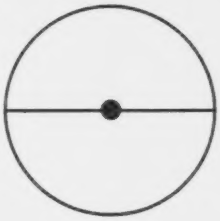
Procedures	**On computer**
	None

Evaluation / Assessment	Write on the board some values from a CNC display that are in degrees. Ask the students to tell you what the numbers represent, by drawing an angle, the arc, and the value with the degree symbol.
Resources	Essential Mathematics for Life, Book 7.
Homework	Try this! Suppose you had a pizza and divided into 8 slices. What would be the angle for each slice? How about 6 slices? 10 slices? 3 slices? 20 slices? Try this! Suppose you had pizza and divided it in half. One half is for you and your spouse, and the other half for your 5 kids. If you gave them each an equal sized slice, what would the angle be? What would the angle be for the piece you and your wife eat? Try this! Suppose you had 12 people to feed pizza to, and they each want a slice that is 45°. How many pizzas will you need? How much, if any, pizza will be left over? Draw it out to help you.

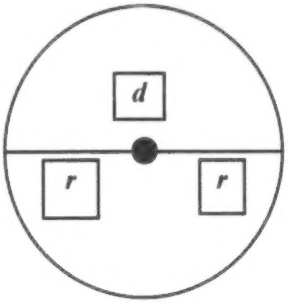
Unit: Geometry

Circles

Description	In this lesson, students will learn some very basic things about circles. Specifically, the lesson will cover radius, diameter, and circumference. Pie (π) will be introduced only for circumference calculations.
Objectives	*The student will be able to*: ➢ Given a circle, identify the radius and diameter. ➢ Define circle, radius, diameter and circumference. ➢ Write the proper symbols for pi, radius and diameter and pronounce them. ➢ Given pi calculate the circumference ➢ Given a radius, calculate the diameter and/or circumference. ➢ Given a diameter, calculate the radius and/or circumference.
Prerequisite skills	*Students should*: ➢Be able to draw a circle. ➢Be able to draw a line. ➢Have a working understanding of measurement (measuring).
Technology Utilization	None
Materials	Paper, pencil, calculator, whiteboard and markers. Soda cans or some other perfect circle and rulers
Teacher to Teacher	**Key concepts and vocabulary words:** *circle, point, equal, distance, center, radius, symbol, diameter, twice, circumference, perimeter, pi (π).* ***Time***: 1 hour lecture and nominal setup. Group work is not necessary. Be prepared for students who understand the material and move quickly. Students must have the prerequisite skills listed above before beginning this lesson. Be sure to review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 7, 159-160 and 171-172

Purpose	Both gears and pinions have an overall shape of a circle. Some of the manufacturing processes in the plant require an understanding of some basic information about circles. Also, these skills are necessary for more advanced math topics.
Procedures	**Off computer**
	1. Introduce the lesson by stating objectives and purpose. 2. Review prerequisites by asking students to tell you what they mean (e.g., "What are some common units of measure?") or even to demonstrate the skill (e.g., "Draw a circle"). Review any prerequisite skills not mastered. 3. Ask students what are some common things they use that are in the form of a circle. Write them on the board. Ask if they ever wondered how to figure out the distance around the circle? This is something we will learn today. 4. Draw some perfect circles of various sizes. Explain that a circle, by definition, is a figure in which all the points are at an equal distance from the center. Use a ruler to show that all the points are the same distance from the center. 5. Draw some non-examples on the board, such as ovals. Use the ruler to show that all the points are not the same distance from the center. 6. Give the students a soda can or something that is perfectly round so they can draw their own circle. They will need a ruler too. Explain to the students that the distance from the edge of the circle to the center is called the radius. Tell them to use their ruler, and as best they can draw a straight line through the center.  7. Tell the students to measure the line. Ask them how the center of that line would be calculated. If one supplies the correct answer (divide by 2 or take half) give positive reinforcement and explain to those who do not follow. 8. Now that they know to divide the length of the line by two, tell the student to do so, and do draw a dot at that point. They now have identified the center of the circle. 9. Tell the students to measure the distance from the edge of the circle to the dot anywhere along the circle. Because they are all the same, we truly have a circle. Review again the definition of a circle.

10. Review: ask the students what they did to determine the center of the circle.
11. Tell them "Guess what! You already know the diameter and radius!". Explain that the diameter is the distance across the circle through the center, and that the radius is half that or the distance from the center to edge.
12. Ask the students to tell you the diameters and radiuses of their circles.
13. Draw more circles on the board and illustrate the point. Show some non-examples by drawing a line that does not go through the center of the circle. Perhaps even draw one that is not through the center, and ask the class if they believe that is a diameter.
14. Reinforce the concepts of diameter and radius. Write a "*d*" and a "r" on the board and explain that they are the symbols used for diameter and radius. Ask them to write their own values on their paper using the proper symbols, and check their work.
15. Ask students to draw another circle of a different size using a jar or something, and to draw the diameter and the center. Ask them to determine the diameter and radius, and to label it on their diagram using the proper symbols. Make sure they understand that $d = 2r$ or $r = \frac{1}{2}d$



16. Now on to circumference. Explain that the distance around the perimeter of a circle is called the *circumference*. The symbol is *C*. If you had a huge circle and walked around the perimeter, that distance would be the circumference. Explain that the circumference can be calculated by just knowing the diameter. Show how you could not use the ruler to measure the circumference, but we can use are ruler to measure the diameter.
17. Write the formula on the board: $C = \pi d$. Ask if anybody knows about pi. Explain that pi is a Greek letter that is used in math to calculate things like the circumference of a circle.

	18. Explain that the formula is really simple to use. Multiplying the diameter, which we can measure with our ruler, by pi will give us the circumference. 19. But what is pi (π)? Pi is equal to 22/7 or about 3.14. Draw some circles on the board and some sample radii, such as 5 inches, 22 inches, 6.7 inches, etc. Ask the students what the diameters are. Now ask them how to figure out the circumference. Refer them back to the formula on the board if necessary. Perform the multiplication on the board. Ask the students to calculate C for the circles they drew. 20. For practice, write on the board a number of problems such as "What is the diameter and circumference of a circle with a radius of 3.5 feet.?" or "What is the diameter of a circle if the circumference is 8 meters?" Let them work in pairs. Check their work. 21. Explain how to do the problems like the second one in step 20 if any have trouble.

Evaluation / Assessment	Ask the student to explain what we learned today, getting them to be specific (e.g., "The symbol for radius is r").
Resources	
Homework	Try this! Take your ruler and find circles around your home, such as soup cans or whatever. Determine the circumference. Try this! Suppose you have a fenced in back yard which is 20 yards wide and 20 yards long (a perfect square), and you want to put in a round swimming pool (a perfect circle). Will a pool with a circumference of 40 yards fit? If so, how much space on each side will there be between the pool and the fence. What is the circumference of largest pool that will fit in your yard? Try this! Write a paragraph about where the value of pi (π) came from.

Unit: Geometry

Cartesian Coordinate System

Description	In this lesson, students are introduced to the Cartesian Coordinate System. The lesson begins with a discussion of the basic concept of the rectangular coordinate system including horizontal and vertical axes. Students will learn to identify and label coordinates (points) on a coordinate grid. Next, the lesson introduces a third axis, depth. The left-hand rule is explained as an easy way to remember the three different axes. Finally the lesson ends by discussing the three rotating axes, A, B, and C.
Objectives	Students will be able to: ➢ Describe the Cartesian coordinate system. ➢ Accurately identify the X, Y, Z ,A, B, and C axes, given an unlabeled graphic of the six axes. ➢ Accurately plot points on a coordinate grid, given the x and y coordinates. ➢ Accurately name the coordinates of points given a labeled coordinate grid.
Prerequisite skills	Student should have knowledge of: ➢ Whole numbers ➢ Positive and negative numbers
Technology Utilization	➢ The Cartesian Coordinate System module of *Get it in Gear!* is accessed from the Main Math Menu. ➢ Department 74-1 in the Process Flow program (if available).
Materials	Computer, *GiiG* software, disk, graph paper, pencil, calculator, whiteboard, markers and Cartesian Coordinates handout.
Teacher to Teacher	**Key vocabulary and concepts:** ***ordered pair, coordinate, coordinate system, Cartesian coordinate system, X-axis, Y-axis, Z-axis, horizontal axis, vertical-axis, depth, A, B, and C axes, plane***. ***Time***: approximately 1 hour lecture and 1 hour on computer; nominal setup. Emphasize that this is an introductory lesson only. The focus should be on helping students become familiar with the math terms related to CNC. These concepts are critical for understanding the CNC operations. Emphasize workplace applications as much as possible: ➢ CNC machines are based on coordinate systems that use two or more axes ➢ Automobile parts must have very precise measurements to work properly. CNC equipment use the different axes to make precise cuts in gears, pinions, and other manufacturing parts. ➢ What actually happens as different numbers appear on the CNC panel, relate to machine movements.

	Familiarize yourself with the Cartesian Coordinate Module before having students use the *GiiG* software. Be sure to review the student's pre-test to determine areas of weakness.
Unit Pre & Post test	Essential Mathematics For Life, Book 5, pp.140-141 and 156-157

Purpose	This lesson will introduce students to the Cartesian coordinate system. Explain that the coordinate system is used to identify and locate position. CNC machines use computer programs to precisely move cutting tools from one location to another in order to cut workpieces precisely and accurately. As automation increases in manufacturing, workers must become familiar with computerized equipment and be able to perform adjustments necessary for quality control.
Procedures	**Off computer**
	1. Introduce lesson by explaining the purpose and objectives. 2. Help students recall prerequisite concepts for whole numbers, positive and negative numbers, and decimal numbers. 3. Begin lesson by asking students how they would use a city map to find an unfamiliar street. Or ask how would they give directions to someone trying to find a specific location. Use their responses to introduce the concept of an ordered pair of a coordinate system. 4. Define ordered pair and coordinate grid. Draw a grid on the board and demonstrate how ordered pairs are used to find the location of any point on a grid. Work through a couple of examples. Point out that CNC equipment moves the workpiece, or cutting tools to an exact location that is specified by an ordered pair of numbers. 5. Explain that a **rectangular coordinate system** is made of two perpendicular number lines. The system is two dimensional and lies upon a plane (flat surface that has no boundaries) Provide examples (e.g. paper, photograph). ➢ Using the grid on the board, define the horizontal, X-axis and vertical, Y-axis. Explain how each number in an ordered pair is a **coordinate** of the system. Discuss relationship of an ordered pair and its X, Y coordinates. ➢ Discuss relationships to CNC equipment. The X axis moves a work piece or tool in a horizontal direction (right and left); the Y axis moves in vertical direction (front and back). Have students look at their graph paper as it lies on the desk to visualize direction and movement. ➢ Extend the number lines to include negative numbers and explain that X and Y coordinate may be negative numbers. Discuss coordinates that fall on the number line (X = 0, Y = 0).

  - Demonstrate plotting coordinates with positive and negative numbers. Work through examples on the board.
  - Note: Have students think of street intersections as X and Y axis to help them visualize the concept.

6. Have students work individually or in groups of two to practice plotting coordinates.
   - Use graph paper numbered 0-10 on the horizontal and vertical axes and letters of the alphabet located at different points on the grid.
   - Provide the coordinates (ordered pair) and have students find the letter of the point.
   - Provide the letter of a point and have students find the coordinates.
   - Include examples of positive and negative coordinates.
7. Explain and discuss **The Cartesian Coordinate System** has three number lines perpendicular to each other. Each axis can have positive or negative direction. Use handouts of Cartesian coordinates.
   - To represent 3-D workpieces, we use a three-axes coordinate system.
   - Discuss how workpieces are part of a three dimensional (3-D) system because they have depth. Have students think of gear blanks and relate the third dimension to drilling a hole into the blank.
   - X, Y, and Z axes relate to location and direction.
8. Describe the left-hand rule as a simple way to remember positive Cartesian coordinates.
   - Middle finger = x-axis, index finger = y-axis, and thumb =z-axis. Have students demonstrate the technique.
   - Show pictures of different machine tools and the x, y and z axis. Ask students to give examples from the plant floor of how these axes are used in machining operations.
   - Have students look around the room for examples of objects. representing the Cartesian coordinates (e.g. corner of the room where the walls and floor intersect, the corner of the desk).
9. Discuss the concept of rotation on machine tools.
   - Some machining operations relate to the rotation around one or more coordinate axes.
   - A, B, and C are rotation axes. The direction of rotation is defined by positive or negative numbers: positive is clockwise, negative is counter clockwise.
   - A-axis rotates around the X-axis; B-axis rotates around the Y-axis; C-axis rotates around the Z-axis.
   - Show pictures of different machine tools and the A, B and C axis.
10. Have students practice by working on the Cartesian Coordinate System module on the computer.
11. Review

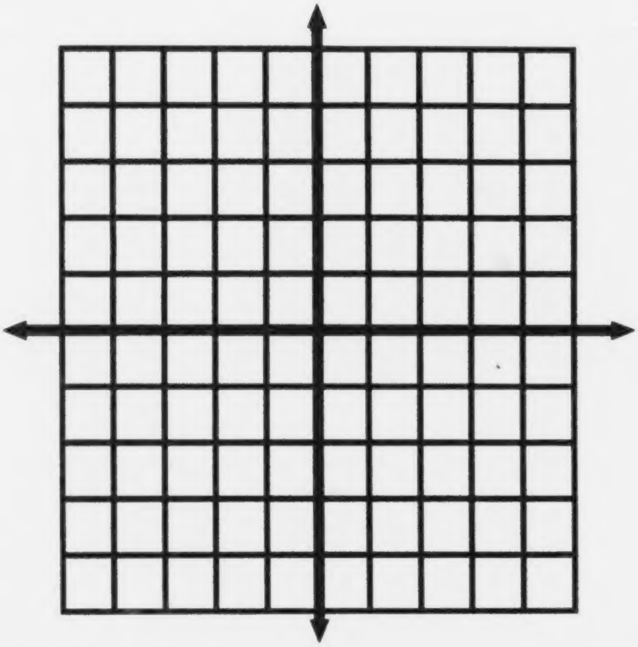
Procedures	**On Computer**
	• Have students launch *GiiG* program and work through the Cartesian Coordinate Module in the *GiiG* software. • Review "How to use *GiiG*" for technical assistance. • You may want students to look at Department 74-1 in the process flow software to see CNC machines in operation.

Evaluation / Assessment	Have students describe in their own words the Cartesian coordinate system. Evaluate students checking for understanding comments on the computer. If necessary, use the Cartesian Coordinates Practice handouts for additional practice. Identify and label X, Y, Z, A, B, and C axes. Identify he coordinates for points shown on a coordinate grid. Using the coordinates for a set of points, locate and label each point on a coordinate grid. Use graph paper to simulate the coordinate grid. This is the last lesson in the unit, so lets play a game! Divide the students up into three teams. Put a problem on the board relating to the three lessons in the Geometry unit. The team who gets the correct answer first gets a point. Use word problems.
Resources	• Essential Mathematics for Life, Practical CNC-Training • *GiiG* Software
Homework	Try using a blueprint or picture of a gear or pinion drawn on graph paper. Have students identify coordinates of various points. For example the top, bottom, front, back, middle, etc.

Cartesian Coordinates Practice

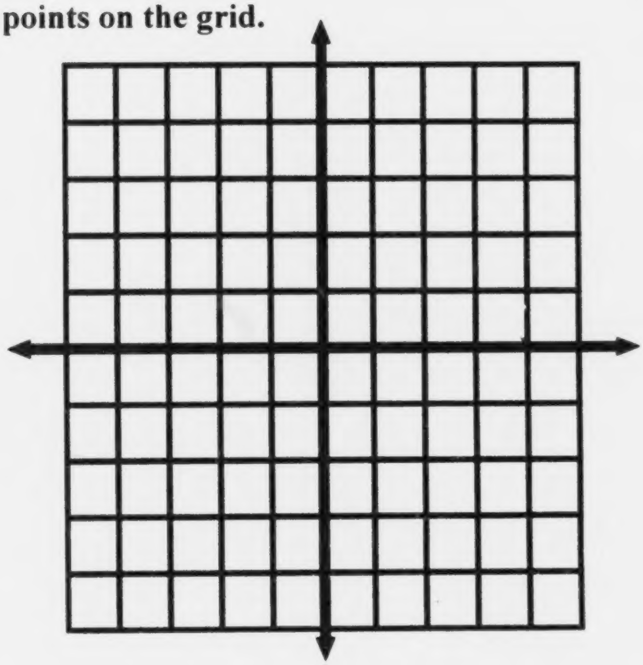
Locate and label the following points on the grid.

1. **Point A = (0, 3)**
2. **Point B = (4, 4)**
3. **Point C = (-5, 0)**
4. **Point D = (-2, 1)**
5. **Point E = (-5, -5)**



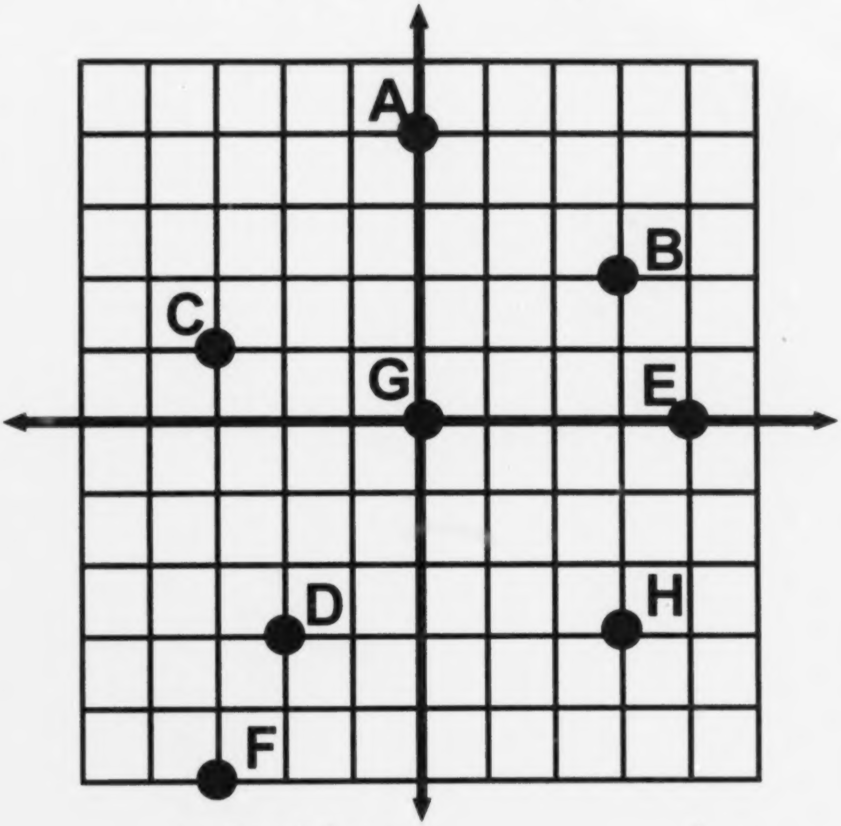
Locate and label the following points on the grid.

1. **Point F = (-3, -1)**
2. **Point G = (0, -4)**
3. **Point H = (1, -1)**
4. **Point I = (-3, -5)**
5. **Point J = (0, 0)**



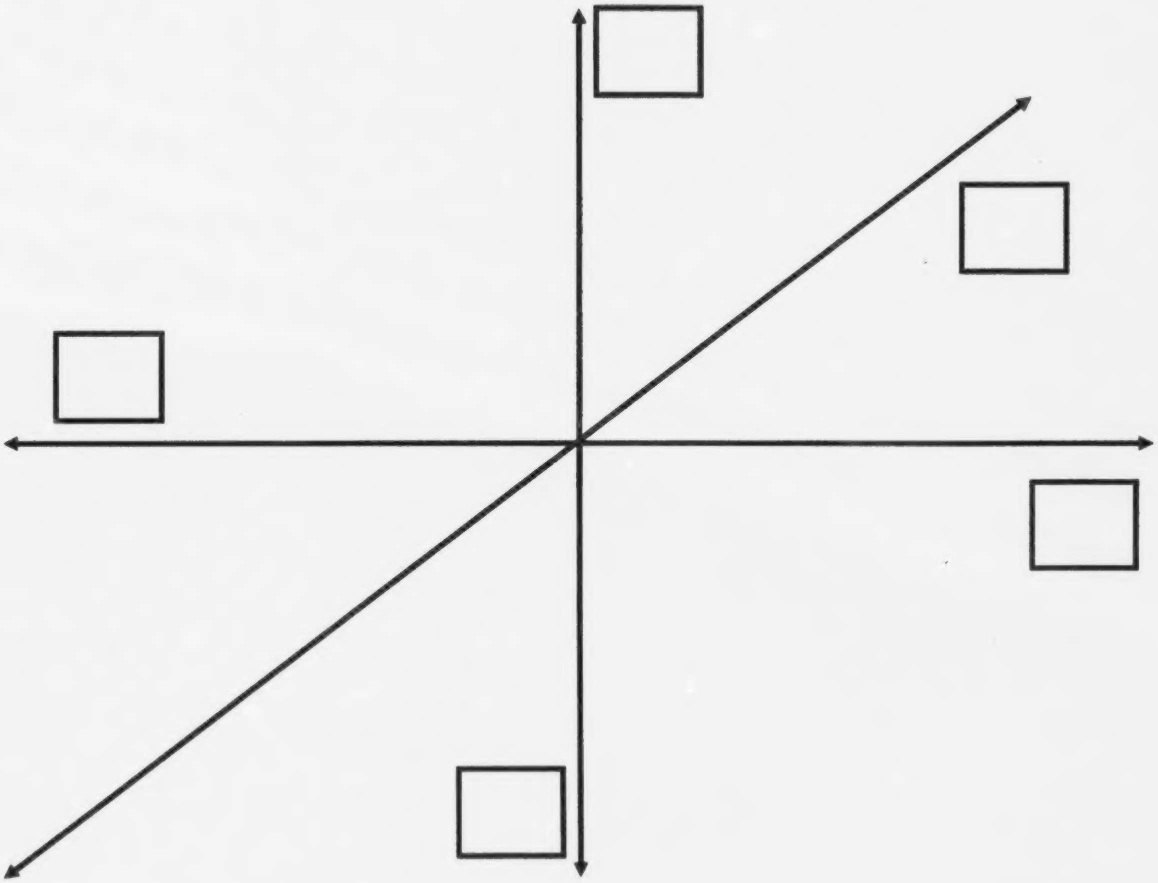
Cartesian Coordinate Practice

Write the coordinates for each point shown on the grid



1. **Point A = (________, ________)**
2. **Point B = (________, ________)**
3. **Point C = (________, ________)**
4. **Point D = (________, ________)**
5. **Point E = (________, ________)**
6. **Point F = (________, ________)**
7. **Point G = (________, ________)**
8. **Point H = (________, ________**

Cartesian Coordinate Practice



Metric System

Unit: Metric System

Metric Numbers

Description	In this lesson, students will learn about the metric system, including the metric units of measure, how it differs from US Standard, and the symbols used in the metric system. Conversion is NOT covered.
Objectives	*Student should be able to*: ➢ Describe the metric system: ➢ State the metric units of measure. ➢ Write the proper symbols used in the metric system. ➢ Describe the metric units of measure are and their use (e.g., meters is used to measure length).
Prerequisite skills	*Student should have knowledge of*: ➢ Whole numbers ➢ Positive and negative numbers
Technology Utilization	The Metric System *module of GiiG!* software.
Materials	*GiiG* software, disk, graph paper, pencil, calculator, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words:** *metric, length, weight, volume, capacity, temperature, Celsius, liter, gram, meter, kilo-, milli-, centi-, measure, system, decimal, base 10.* ***Time:*** Less than one hour lecture and nominal setup time. Group work is not necessary. Be sure to review the computer module, The Metric System, before using it as an instruction tool. Be prepared for students who understand the material and move quickly. Students must have the prerequisite skills listed above before beginning this lesson.
Unit Pre & Post test	None

Purpose	While some manufacturing plants use the US Standard of measurement, many will convert to metric the near future. Machine readings will be different because of the new measuring system, therefore, it is important to understand both systems.

Procedures	**Off computer**
	Introduce the lesson by stating objectives and purpose.
	1. Review prerequisites by asking students to tell you what their experience with the US standard system has been, giving examples. Review any prerequisite skills not mastered.
	2. Ask students about their experience with the metric system. 3. Write them on the board. Prompt for more if they have not provided at least one example corresponding with of length, weight, volume (capacity) or temperature. 4. Introduce the concepts of length, weight, volume (capacity) and temperature by categorizing their responses. Define those terms. 5. Explain that the metric system is a system of measure that is based on the decimal system (base 10) and so is easier to use. 6. Under each category write the appropriate metric unit (i.e., liter, Celsius, gram, meter). 7. Explain that they will use the software to learn more about this topic. 8. Explain to the students that the distance from the edge of the circle to the center is called the *radius*. Tell them to use their ruler, and as best they can draw a straight line through the center.
Procedures	**On Computer**
	Have the students launch *GiiG!* (note see the section How to use *GiiG!* for technical assistance). Direct the students to the Metric System module on the main menu. Facilitate as needed.

Evaluation / Assessment	This is the only lesson in the unit, so lets play a game! Divide the students up into three teams. Put a problem on the board relating to the Metric System. For example, "What is the symbol for liter?" or "The team who gets the correct answer first gets a point.) Use word problems.
Resources	*GiiG* Software
Homework	Try using a blueprint or picture of a gear or pinion drawn on graph paper. Have students identify coordinates of various points. For example the top, bottom, front, back, middle, etc.

Magnitude

Unit: Magnitude

Magnitude

Description	In this lesson, students will learn about magnitude and will gain an understanding and appreciation for numbers which are either very small or very large.
Objectives	*The student will be able to*: ➢ Define magnitude. ➢ Recognize numbers that are either very very small or very very large.
Prerequisite skills	*Student should be familiar with*: ➢ Numbers. ➢ Place value and place.
Technology Utilization	The Magnitude module of *GiiG!* software.
Materials	Computer, *GiiG* software, disk, paper, pencil, calculator, whiteboard and markers.
Teacher to Teacher	**Key concepts and vocabulary words:** *magnitude, large, small, accurate, place, place value.* ***Time:*** Lecture time is less than one hour, as the instruction will be primarily delivered via the multimedia. Setup time is nominal. Group work is not necessary. Be sure to review the computer module before using it as an instruction tool. Be prepared for students who understand the material and move quickly. Students must have the prerequisite skills listed above before beginning this lesson.
Unit Pre & Post test	None

Purpose	Many of the computer panels used throughout the plant on various machines display numbers (often a distance measurement of some kind) that are either very small, or are accurate to the ten-thousandths place which is very small. It is important to be able to recognize and appreciate how small these values can be. It all comes back to the need for accuracy in the plant, and realizing that these machines can perform operations that are quite minute. A cut accurate to the ten thousandths of an inch is very accurate. Understanding how small a number like 0.0005 is important.

Procedures	Off computer
	Introduce the lesson by stating objectives and purpose. 1. Review prerequisites by asking questions about place value, etc.. Review any prerequisite skills not mastered. 2. Ask students about their experience with numbers which are very large or small. Ask how large they think a number like one million is. 3. Write the word magnitude on the board and define it. Explain that 4. Explain that they will use the software to learn more about this topic.
Procedures	**On Computer**
	➢ Have the students launch GiiG! (note see the section How to use GiiG! for technical assistance). ➢ Direct the students to the Magnitude module on the main menu. ➢ Facilitate as needed.

Evaluation / Assessment	Start a discussion about magnitude, and the students experiences with large and small numbers in the plant. Be sure they appreciate how small a ten-thousandths of an inch is, and that for a machine to be able to operate at such a very very small distance, it must be very accurate. Accuracy is one reason we have the CNC machines. Make sure that for now on when they see a number, they reflect for a second on just how big or large that number is. This way, they will really appreciate just how large a number like one million is, even though it just "rolls off our tongue".
Resources	*GiiG* Software
Homework	Try this! Find numbers in the paper and order them by magnitude.

Glossary for Math for Machine Operators

A axis - the axis of circular motion of a machine tool member or slide that rotates around the X axis

abbreviation: a short way of writing something. The abbreviation for Quality Control is QC.

angle - a figure formed when two rays meet at a single point

average - the average of a set of numbers is found by adding a set numbers together and dividing by the amount of numbers that make up the sum.
Ex. 12 + 14 + 15 + 19 = 60 60 -:- 4 = 15

axes - the plural of *axis*, more than one axis

axis -- the line on a graph, there are usually 2 axes, one horizontal (left to right) and one vertical (up and down)

B axis - the axis of circular motion of a machine tool member or slide that rotates around the Y axis

bar graph -- a graph that uses bars (stripes or bands) to picture the relationships among numbers. Bar graphs show data based on a vertical axis and a horizontal axis in the form of bars. They are very good for comparing information.
basic operations

base - a number that is multiplied by itself in a power. In the number 3^2, the 3 is the base. Multiply the 3 by itself 2 times. (3 x 3)

basic math signs and operations -

+ addition or positive number
- subtraction or negative number
x multiplication or unknown number
/ division
-:- division
> greater than
< less than

C axis- Normally the axis of circular motion of a machine tool member or slide that rotates around the Z axis

canceling- a shortcut when multiplying fractions. It means dividing a top and a bottom number by a figure that goes evenly into both before actually multiplying. It is not necessary to cancel to get the right answer, but it makes multiplying easier.

Cartesian coordinates - a system whereby the position of a point can be defined with reference to a set of axes at right angles to each other
chart -- a graphic representation of data that lists exact numbers in columns and rows
common denominator

chart -- a graphic representation of data that lists exact numbers in columns and rows

circle - a figure whose every point is the same distance from its center

circumference - the distance around a circle

CNC - computer numerical control

column -- a group of numbers or words that are listed vertically, (up and down) in a table or chart

computer numerical control (CNC) a numerical control system utilizing an onboard computer as a machine control unit.

convert - change, Ex. *convert* a fraction to a decimal means to change a fraction to a decimal

communication -- the process of sending a message through selected channels to a receiver and then getting feedback to check for mutual understanding.

communication skills -- The way we give information to others and receive information from others. Reading, writing, speaking, and listening are communication skills.

compare -- to look at two or more numbers and see their similarities and differences; also to decide which is larger or smaller.

convert -- to change one thing to another. Sometimes it's necessary to convert meters to yards.

coordinate system - two perpendicular number lines that intersect at zero

data - a representation of information in the form of digits, numbers, words, symbols, letters, characters, etc. Sometimes called a **set**

decimal -a number written with a decimal point. Decimal values smaller than 1 are written to the right of the decimal point (0**.22**). The decimal values smaller than 1 are also called **decimal fractions**

decimal fraction - a fraction whose denominator is a power (multiple) of 10

$.5 = \frac{5}{10}$, $.22 = \frac{22}{100}$ $.456 = \frac{456}{1000}$

decimal point - a dot written in a series of numbers that has the places of whole numbers to the left of it and decimal places to the right of it (123**.**456)

degree - a unit of measure for an angle

denominator - the bottom number of a fraction, it wills how many parts are in the whole

diameter - a line segment that passes through the center of a circle and ends on the circle's edge

difference - result of a subtraction problem. The difference of 7 - 2 is **5**

digit - a symbol for a number. The digits are 0, 1, 2, 4, 5, 6, 7, 8, and 9

dimensions -- the length, width, and/or depth of an object. The dimensions of the sheet of steel were: length, 10 feet; width, 5 feet

dividend - in a division problem, the number being divided

divisor - in a division problem, the number that an amount is being divided by

equal - being the same or identical to in value

estimate - to find an approximate answer by using rounded numbers

exponent - a number that tells how many times to multiply the base by itself. In the number 3^2, the 2 is the exponent. Multiply 3 by itself 2 times (3 x 3)

fraction -- a part of a whole, a number less than one but greater than zero Ex. $\frac{1}{4}$

graphs - a picture or map of numbers, tools for displaying data. There are many different kinds of graphs including bar graphs, line graphs, and pie charts or circle graphs.

higher terms - to change a fraction to larger numbers so you can continue with adding, subtracting, multiplying and dividing. $\frac{1}{5}$ can be raised to $\frac{2}{10}$ or $\frac{20}{100}$

horizontal line - line parallel to the horizon

improper fraction - the top number is *equal to or larger than* the bottom number.

intersect -- to meet and cross at a point, in a chart or table

invert - means to turn a fraction upside down. $\frac{7}{10}$ can be inverted to $\frac{10}{7}$

leading zero - a zero that is the only digit before a decimal point. The leading zero can be dropped without changing the value of a number. **0**.8 is the same as .8

line - a straight path of points that continues in two directions

lowest terms - to change a fraction to the lowest numbers possible. $\frac{2}{8}$ can be reduced to the lowest terms of $\frac{1}{4}$.

math operations - are addition, subtraction, multiplication, and division

mean - the average of a set of numbers, calculated by adding a set numbers together and dividing by the number of sets in the sum. Ex. 12 + 14 + 15 + 19 = 60 60 -:-4 = 15

median - the middle number of a set of numbers that are arranged from smallest to largest; If the set has an even number of numbers, the median is one-half way between the two middle numbers. Ex. (1, 2, **3**, 4, 5), the median is **3**; (2, 4, 6, 8), the median is **5**

metric system -- a system of measurement based on tens, used by most people outside the Untied States. Unites such as centimeters, millimeters, grams, and kilograms are used in the metric system

minus sign (-) - The sign for subtraction or a negative number

mixed numbers - a whole number written next to a proper fraction, $3\frac{1}{3}$. To perform math operations to some mixed numbers, they must be changed to improper fractions.

$3\frac{1}{3}$ is changed to $\frac{10}{3}$.

mode - the number that occurs most often within a set of numbers

multiplication sign (x) - the sign for multiplication.

negative number - a number less than zero

numerator - the upper number of a fractions, it tells how many parts you have

offset - a change in the axial direction of the tool which is the difference between the actual length and the programmed length

order of operations - the acceptable order in which to do calculations when a problem has more than one step: 1. any operation in parentheses, 2, exponents, 3. multiplication and / or division, from left to right, and 4. addition and/ or subtraction, from left to right. Pneumonic: **P**lease **E**xcuse **M**y **D**ear **A**unt **S**alley

ordered pair - points on a coordinate grid that are defined by a set of numbers (coordinates). The X-axis value is given first; the Y-axis value is second (2,3)

percent - a part of a whole that is divided into 100 equal parts. The symbol % means percent
25 percent is 25 parts out of 100 parts; 25% means 25 percent

perimeter - the distance around a flat figure

perpendicular - two intersecting lines that form a right angle .

place value - the position a digit holds in a number

pi (π) - the ratio of the circumference of a circle to its diameter, approximately 3.14 or $\frac{22}{7}$

point - a location in space that has no thickness

proper fraction - the top number is less than the bottom number -- $\frac{1}{3}$

precision - an exact or accurate measurement

plane - flat surface (such as a table top or work surface) that extends infinitely in every direction

plus sign -(+) - the sign for addition or a positive number

positive number - a number greater than zero

power - a number multiplied by itself

product - the answer to a multiplication problem. The product of 3 x 5 is **15**

quotient - the answer to a division problem. The quotient of $3\overline{)15}$ is **5**

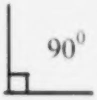
radius - (of a circle) a straight line connecting the center of a circle to a point on the circle. The radius of a circle is one-half the length of the diameter. The plural form of the word radius is radii.

range - the difference between the smallest and largest numbers of a set. Ex. (2, 4, 6, 8, 10) the difference is 10-2 = **8**

reduce (a fraction) - means writing it with smaller numbers. $\frac{25}{100}$ can be reduced to $\frac{1}{4}$

relationship -- a connection between people or things. Graphs and charts show the relationships of numbers

right angle - an angle measuring 90^0



rounding - changing the value of a number slightly to make it easier to work with.

set - a group of numbers (1, 2, 3, 4)

SPC -- Statistical Process Control is a method companies use to achieve quality; a method of gathering and analyzing data to solve practical quality problems. Controlling the process with statistical methods to guide in the outcome of quality products or parts whole numbers

statistics -- summaries of data; the science of collecting, organizing, and analyzing data to draw conclusions

table -- a graphic representation of data that lists exact numbers in columns and rows

technology -- Machines and ways of doing things that improve the speed and/or quality of work. The use of computers in manufacturing is an example of modern technology.

U. S. customary units -- the way people in the United States usually measure, using units such as inches, feet, miles, ounces, and pounds. In many industries, U. S. customary units are being replaced by the metric system.

vertex - a point where two rays or two line segments meet

vertical line - Line perpendicular to the horizon

whole numbers - the numbers most commonly used in counting (0, 1, 2, 3, 4, . ..)

width -- the distance from one side to another of something. In rectangles, the shorter dimension. The length of the rectangle was 50 centimeters, the width was 20 centimeters

x - the sign for multiplication. Can also stand for an unknown number.

X axis - the horizontal number line on a coordinate grid. For CNC machines it is the axis of motion that is always horizontal and parallel to the workhold surface

Y axis - the vertical number line on a coordinate grid. For CNC machines it is the axis of motion that is always perpendicular to both the X and Z axes

Z axis - Axis of motion that is always parallel to the principle spindle of the machine. It is used to measure thickness or depth of the piece

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Preview for Math for Machine Operators

Name: ______________________________ *Date:* ______________________

Circle the correct answer.

1. What is the *place value* of the underlined number in **389.487**?
   a. hundredths
   b. thousands
   c. hundreds
   d. thousandths

2. What is the *place value* of the underlined digit in **45.960**?
   a. hundredths
   b. thousands
   c. hundreds
   d. thousandths

3. What is the name of the *dot* in the number **10.5**? ____________ ____________
   (2 words)

4. What is the *average* of the following numbers? ______________
   20, 27, 25, 23, 30

5. What is the *range* of the following numbers? ______________
   148, 196, 149, 147, 188

6. Circle the *largest* number.

   a. .001

   b. .0009

   c. .0015

   d. .012

7. Circle the *smallest* number.

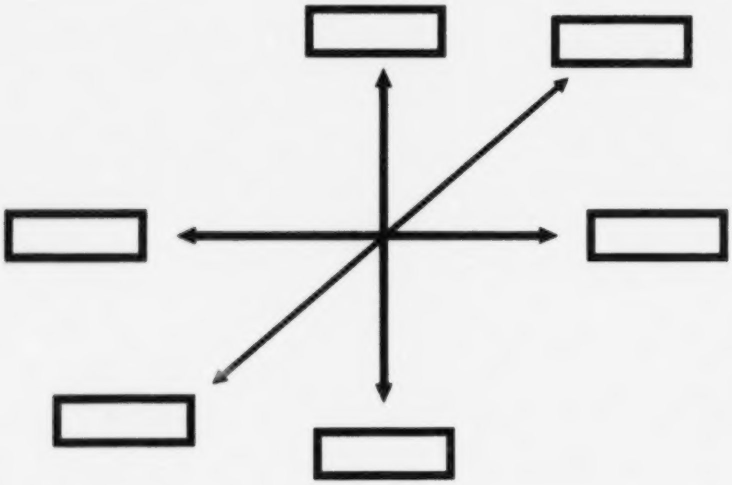
   a. .001

   b. .0009

   c. .0015

   d. .012

8. Label *each axis* of the Cartesian coordinate system.



9. What does ***15º C*** measure?

   a. length/distance

   b. volume

   c. temperature

   d. weight

10. In the word *millimeter*, the prefix ***milli-*** stands for:

   a. tenths

   b. hundredths

   c. thousandths

   d. ten thousandths

11 Write ***one hundred and eighty nine hundredths*** as a number. ____________

12. Which are the *correct words* for the number **7.0030**

   a. seven and three tenths

   b. seven and three hundredths

   c. seven and three thousandths

   d. seven and three ten thousandths

Solve the following problems.

13. **–5 + 2 =** ____________

14. **–7 – 4 =** ____________

15. **12.5 + 6.5 + 3 =** ____________

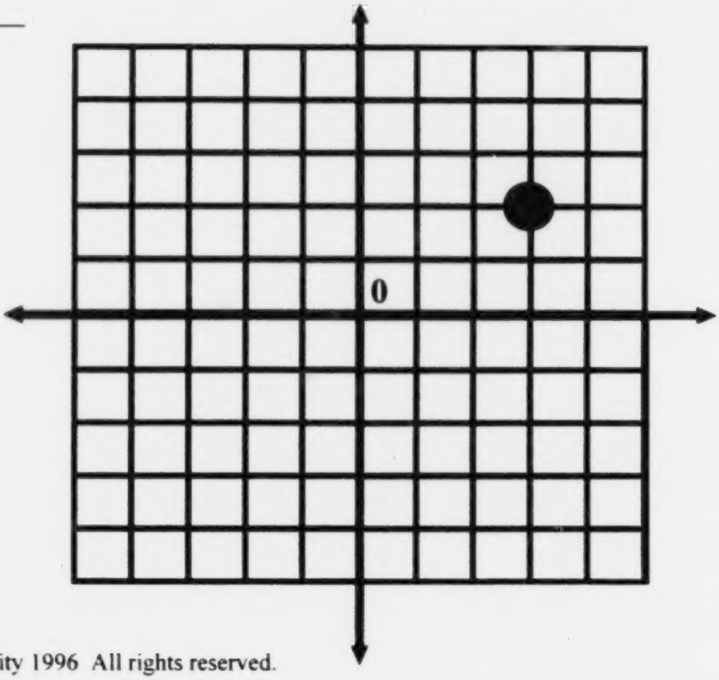
16. **2.46 + .005 +16=** _____________

17. **9.2 – .07 =** ______________

18. **499 – .05 =** ____________

19. What is the *ordered pair* (coordinate pair) for the dot on the diagram?

____



Review for Math for Machine Operators

Name: ______________________ *Date:* ____________________

Circle the correct answer.

1. What is the *place value* of the underlined number in **389.487**?

   a. hundredths

   b. thousands

   c. hundreds

   d. thousandths

2. What is the *place value* of the underlined digit in **45.960**?

   a. hundredths

   b. thousands

   c. hundreds

   d. thousandths

3. What is the name of the *dot* in the number **10.5**? __________ __________
   (2 words)

4. What is the *average* of the following numbers? ____________

   20, 27, 25, 23, 30

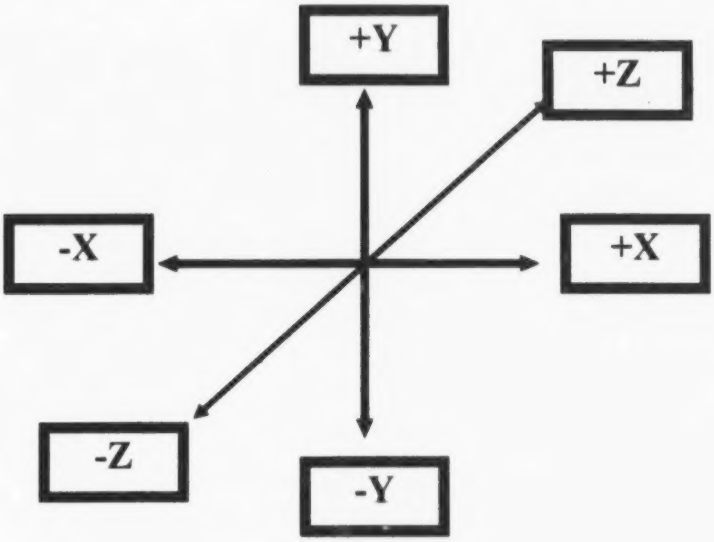
5. What is the *range* of the following numbers? ____________

   148, 196, 149, 147, 188

Answer Key

Preview and Review - Math for Machine Operators

1. d thousandths
2. a hundredths
3. decimal point
4. 25
5. 49
6. d .012
7. b .0009
8.



9. c temperature
10. c thousandths
11. 100.89
12. c seven and three thousandths
13. -3
14. -11
15. 22
16. 18.465
17. 9.13
18. 498.95
19. (3,2)